VOLUME III MARCH AND JULY, 1904 NOS. 2 & 3

# EXPERIMENTAL AND STATISTICAL STUDIES UPON LEPIDOPTERA.

## I. VARIATION AND ELIMINATION IN *PHILOSAMIA CYNTHIA*.

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### *Prefatory Statement.*

THE present paper consists of an account of a detailed study, by means of statistical methods, of the facts of variation and of the relation between variation and selection in the pupae of the Ailanthus silk-worm moth, *P. cynthia*. The observations here recorded were made more than four years ago, and they have been continued and extended in subsequent years upon the same and other species of Saturnids. Naturally the scope of the later investigations has materially widened, and in addition to the fundamental problem mentioned above, the existence of sexual selection has been examined, as well as a host of other questions which relate to the process of evolution and its factors. Among these may be mentioned the comparative variability of the two sexes, the variability of individuals at various stages in their life-history, the comparative variability of native and introduced species, and the relation between an introduced species and the same species in its original habitat. The problem of inheritance in pure

species has likewise been under investigation, and attempts have been made to cross various species in order to ascertain whether heredity in such cases follows the principles of Mendel.

The lepidoptera afford extremely favourable material for investigations of the above nature, for they can be obtained in considerable numbers, and they may be bred with not too great difficulty. And a qualification of special importance is to be found in the sharp division of their life-history into three well-demarcated periods, each characterized by peculiar external and internal relations. It is of course clear that the structural relations of the imago must be totally different from those either of the larva or of the pupa, and it is equally evident that these forms have entirely diverse relations to the "environment" at large. Therefore the problem of selection derives an added interest from the comparison of elimination as it appears at one stage with that of another period.

Furthermore the imago and the pupa possess attributes which give to each a peculiar value. The former enters upon its final period of life with a rigid and unchangeable organization, incapable for the most part of structural alterations as the result of "functional adaptation." The pupa excites still greater interest on account of its inability to "use" its various organs in any way. Life and adaptive response are here minimized to their lowest values; and helplessly subject to environmental influences and constitutional weakness the pupa awaits the period of renewed activity which culminates in metamorphosis.

It is from the very nature of the case impossible to present the results of the several studies carried forward during the past few years in a simple and condensed form. Merely to enumerate the statistical data which have been accumulated would trespass beyond even liberal bounds. Therefore it has been deemed best to offer the statement of problems and results in a series of papers, each dealing with a well-restricted division of the whole field. The present long-deferred account, which initiates this series, indicates as well the point of departure for the later investigations.

## I. *Introduction.*

The following account is a statement of the results of an examination into the occurrence of "natural selection" in the case of over-wintering pupae of *Philosamia cynthia*, as this species occurred in New York City in the year 1899. It is concerned, therefore, with the existence of a definite relation between elimination on the one hand, and the extent and character of variation on the other; and particular attention is directed towards ascertaining the real basis for the selective process.

In previous years, when large numbers of the cocoons and pupae of this species had been collected for other purposes, it had been noticed that a great many cocoons contained individuals which had died, although they were apparently perfectly

normal. And it also appeared that many of the normal living pupae failed to metamorphose perfectly, whether they were kept in the laboratory or out of doors. The opportunity thus offered was taken for an examination into the phenomena of elimination for two successive developmental periods. The first, or period of *pupal elimination*, extends from the formation of the cocoon and pupation to the beginning of the formation of the imago. The second period immediately supervenes, and, as the period of *pupal-imaginal elimination*, is marked by the deeply-seated structural and physiological changes of metamorphosis. The reduction of the second period, which results in the weeding out of certain of the *adult* moths, is none the less entirely dependent upon the ability of the *pupa* to accomplish successfully the production of the imago. On this account, as well as for the reason that the moth is constructed in strict accordance with the lines of the pupa, the examination into selection of this second period may justly be conducted with reference to pupal characters. To the two sections in the following account which treat separately these periods of elimination, a third section is added, which deals briefly with the comparative variability of the pupae of the two sexes.

## II. *The Material and its Treatment.*

In December, 1899, all the accessible cocoons were obtained from a small area of less than one acre in the upper part of the City of New York. The cocoons were found principally upon Ailanthus trees, the favourite and original food-plant, where clusters of twenty-eight or thirty were sometimes to be found upon a single branch. Many were taken from vines and fences near these trees, and still others were picked up from the ground whence they had fallen from the trees. It may be noted in passing that these last, far from being unfavourably affected, contained as many living pupae as those which remained attached to the trees.

The total number of cocoons was 1090. Upon examination of the contents, 55 (4·8 °/₀) were found to contain dead and shrivelled individuals which had failed to pupate. Ninety-three contained pupal cases from which the moths, probably of an interpolated summer brood, had escaped, or where, in nine cases, the fully-formed imago had been unable to emerge from the cocoon. Out of the 942 remaining, 623 had pupated, forming in most cases an entirely normal pupa, but they were dead. Thus only 319 "selected" individuals remained to provide for the continuance of the species.

Equal numbers of the dead and surviving pupae were carefully measured, as stated below, and the living ones were kept through the metamorphosis, care being taken to isolate them as this time approached. Only 181 (97 males and 84 females) produced perfect moths, 75 were imperfect to a slight degree, 38 were hopelessly malformed and finally 16 failed to metamorphose at all. The perfect imagines constituted only 16·6 °/₀ of the whole number of individuals which entered the cocoon, from which we may gain an idea of the severity of the conditions under which the quiescent pupa exists.

The comparison of the surviving pupae with an approximately equal number of dead pupae, and the comparison of the perfect survivors with the remainder of the group of survivors, has been based upon the following characters, numbering ten: first, two measures of the pupa as a whole, (1) the total length, the distance

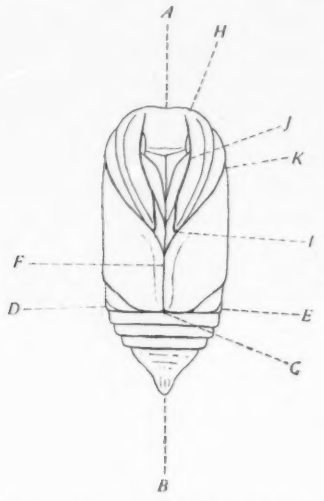



Fig. 1. Diagram of the Saturnid Pupa.

*A—B* in the diagram, and (2) the weight in milligrams; in the second place, a group of characters of the immovable anterior part of the pupa, which may for convenience be termed the "bust," and which extends back to the posterior ends of the wing-cases, at the level of the line between the fourth and fifth abdominal segments. The characters in question are (3) the length of the bust, the line *A—C*, (4) the width of the bust, the line *D—E*, (5) the dorso-ventral depth of the bust, the perpendicular line at the point *F*. From these measures were determined (6) the frontal proportions of the bust, as the ratio between the width and length, and (7) the sagittal proportions, as the ratio between the length and the depth of the bust. In the third place, certain measurements were made of a typical organ, the left antenna, namely (8) the length, the line *H—I*, and (9) the width, as the line *J—K*; from these were determined (10) the proportions of the antenna. All the measurements are in mm.

Of these characters two must be omitted in considering elimination of the first period, namely, length and weight, for after death evaporation and the consequent shrinkage of the free abdominal segments render these characters useless. While it is possible that alterations in the characters of the bust may follow death, thus invalidating any comparison between dead and living pupae, these alterations if indeed they occur, must in the nature of the case be very slight. We shall have

occasion to recur to this point below. But at any rate elimination of the second period need take no account of this possibility. The antennal characters remain unchanged after death.

It will be seen that the "length" of the antenna is only a convenient measure approximating to the real axial length, which dimension it is almost impossible to measure directly. From this it follows that the determination of the antennal proportions is likewise only a convenient approximation, and the value of these characters needs to be further considered below.

Following the usual procedure, the determinations of every character in each sex were classified, and the frequency curve or polygon was plotted. It will be seen that each sex will have for every character five groups: all pupae, surviving pupae, dead pupae, perfect survivors, and the survivors which fail to metamorphose perfectly, which last we may term the imperfect survivors. The characters of the whole group need not concern us at this juncture. Now the comparison between the surviving and dead pupae, or between the two sub-groups of survivors, may be based upon the following constants: (1) the range of variation, (2) the mode, or value of greatest frequency, (3) the average value, or mean, (4) the standard deviation, or the index of variability, a constant found by squaring all the deviations from the mean, adding, extracting the square root, and dividing by the number of cases, and (5) the coefficient of variation, a constant of use in some connections, found by dividing the standard deviation by the mean, and multiplying the quotient by 100 to obtain a convenient whole number. Naturally the data at hand permit of much further mathematical analysis, particularly as regards the phenomena of correlation. For the present however attention may be directed only to the fundamental question as to the relation between variation and elimination and the comparison, for the sake of simplicity, may be restricted to the comparable determinations of the *mean* or average value of any given characters, and of the *indices of variation.*

Before passing to the actual facts, it must be pointed out that statistical treatment of the problem under consideration rests upon the assumption that when differences are found between two corresponding constants, belonging to two different groups, such differences are significant only when they considerably exceed the probable errors of the differences. For example, the bust length of perfect surviving pupae has a certain value for which we may determine the probable error, while the bust length of the comparable imperfect survivors has its mean value with a probable error. If the difference between the two mean values in question should exceed the probable error of such a difference, the chances that the difference signifies selection will be 68 to 32; if the difference exceeds twice the error of the difference the chances of significance are 95 to 5; while if the difference is in excess of three times the probable error the chances of significance are 975 in 1000. Therefore in the following account, a difference between two comparable determinations which lies between the values of $1\epsilon$ and $2\epsilon$ will be regarded as indicating that selection is here *possible*, when the difference

lies between the values $2\epsilon$ and $3\epsilon$ it will be considered that selection is *probable*, while if it exceeds the value $3\epsilon$ selection will be regarded as *certain*. As the same relation obtains between the differences and their probable errors in the case of comparable indices of variation, selection on the basis of variability may be denoted *possible*, *probable*, or *certain*.

## III. *Pupal Elimination.*

### A. *Males.*

The question at issue may be stated in the following form, Are the surviving pupae the same as those which succumb after normal pupation, or are they a selected group? The fact of limitation as regards the number of survivors stands unquestioned. Is elimination selective? Table I. gives the biometric constants for the total or unselected material.

TABLE I.

*All Pupae.*

| Character | Males (264) | | Females (356) | |
|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation |
| Bust, Length ... ... | 18·1987 ± ·0318 | 0·7673 ± ·0225 | 19·3460 ± ·0292 | 0·8192 ± ·0207 |
| „ Width ... ... | 11·0466 ± ·0235 | 0·5675 ± ·0166 | 12·7182 ± ·0223 | 0·6262 ± ·0158 |
| „ Depth ... ... | 12·0031 ± ·0222 | 0·5357 ± ·0157 | 13·5117 ± ·0220 | 0·6178 ± ·0158 |
| „ Frontal Proportions | 60·8220 ± ·1041 | 2·5072 ± ·0736 | 65·8455 ± ·0850 | 2·3776 ± ·0601 |
| „ Sagittal Proportions | 66·0606 ± ·0868 | 2·0916 ± ·0614 | 69·9438 ± ·0716 | 2·0041 ± ·0506 |
| Left Antenna, Length ... | 11·2705 ± ·0230 | 0·5549 ± ·0162 | 11·5124 ± ·0255 | 0·5648 ± ·0180 |
| „ „ Width ... | 4·5829 ± ·0113 | 0·2730 ± ·0099 | 4·2221 ± ·0082 | 0·2293 ± ·0057 |
| „ „ Proportions | 40 7727 ± ·0890 | 2·1447 ± ·0629 | 36·6629 ± ·0682 | 1·9084 ± ·0482 |

In the following Tables II. and III. are given the numerical determinations for answering our first question. The surviving pupae number 134 as against 130 of the dead pupae. Although the facts appear with clearness in the numerical form, a brief verbal statement may not be superfluous. And in such a commentary we may examine separately two questions as to the nature of selection, whether namely it takes place if at all with reference to a certain type, or whether it expresses itself in the figures relating to variability.

In bust measurements, the survivors are found to be longer and narrower than the dead individuals. In both of these characters selection in type is *certain* according to the criterion established in earlier treatment. The survivors are also deeper (dorso-ventrally) than the eliminated pupae, and are selectively different

TABLE II.

*Pupal Period. Selection in Type. Males.*

| Character | Mean; Survivors | Mean; Dead | ($\delta$) Difference | ($\epsilon$) Error of Difference | Proportion of $\delta : \epsilon$ | Selection |
|---|---|---|---|---|---|---|
| Bust, Length ... ... | 18·2313 ± ·0453 | 18·0924 ± ·0440 | +0·1889 | 0·0631 | > 2$\epsilon$ | Probable (almost certain) |
| „ Width ... ... | 10·9014 ± ·0322 | 11·1962 ± ·0320 | −0·2948 | 0·0453 | > 6$\epsilon$ | Certain |
| „ Depth ... ... | 12·0471 ± ·0304 | 11·9577 ± ·0322 | +0·0894 | 0·0441 | > 2$\epsilon$ | Probable |
| „ Frontal Proportions | 59·6865 ± ·1339 | 61·9923 ± ·1294 | −2·3058 | 0·1850 | > 12$\epsilon$ | Certain |
| „ Sagittal Proportions | 65·9029 ± ·1206 | 66·2230 ± ·1243 | −0·3201 | 0·1731 | > 1$\epsilon$ | Possible |
| Left Antenna, Length ... | 11·3514 ± ·0273 | 11·1870 ± ·0367 | +0·1644 | 0·0457 | > 3$\epsilon$ | Certain |
| „ „ Width ... | 4·6844 ± ·0140 | 4·4784 ± ·0156 | +0·2060 | 0·0209 | > 9$\epsilon$ | Certain |
| „ „ Proportions | 41·4105 ± ·1190 | 40·1154 ± ·1211 | +1·2951 | 0·1696 | > 7$\epsilon$ | Certain |

TABLE III.

*Pupal Period. Selection in Variability. Males.*

| Character | Standard Deviation; Survivors | Standard Deviation; Dead | ($\delta$) Difference | ($\epsilon$) Error of Difference | Proportion of $\delta : \epsilon$ | Selection |
|---|---|---|---|---|---|---|
| Bust, Length ... ... | 0·7780 ± ·0320 | 0·7441 ± ·0311 | +0·0339 | 0·0446 | < $\epsilon$ | None |
| „ Width ... ... | 0·5535 ± ·0228 | 0·5424 ± ·0226 | +0·0111 | 0·0321 | < $\epsilon$ | None |
| „ Depth ... ... | 0·5227 ± ·0215 | 0·5450 ± ·0227 | −0·0223 | 0·0312 | < $\epsilon$ | None |
| „ Frontal Proportions | 2·2631 ± ·0932 | 2·1882 ± ·0915 | +0·0749 | 0·1306 | < $\epsilon$ | None |
| „ Sagittal „ | 2·0701 ± ·0852 | 2·1016 ± ·0879 | −0·0315 | 0·1224 | < $\epsilon$ | None |
| Left Antenna, Length ... | 0·4686 ± ·0193 | 0·6218 ± ·0260 | −0·1532 | 0·0323 | > 4$\epsilon$ | Certain |
| „ „ Width ... | 0·2412 ± ·0099 | 0·2645 ± ·0110 | −0·0233 | 0·0147 | > 1$\epsilon$ | Possible |
| „ „ Proportions | 2·0423 ± ·0841 | 2·0470 ± ·0856 | −0·0047 | 0·1200 | < $\epsilon$ | None |

with a high degree of probability. Naturally it follows from the foregoing that the survivors are much more slender in frontal proportions, and the difference between the two groups in this regard exceeds twelve times the error of the difference. In sagittal proportions, however, the narrower survivors are only *probably* different from the others.

Remarkably clear results follow from the comparison of the antennal characters. These organs are not only much longer in the survivors, and wider, but they are also stouter than those of the incapacitated pupae; and in all three characters the difference indicates selection with *certainty*.

Thus we see that in six of the eight characters under consideration, the surviving pupae evidence selection of type: that a typical condition, different from that of the dead pupae, characterizes those individuals which are physiologically "fit" to survive the vicissitudes of pupal existence.

When however we enquire if selection brings about the survival of the less variable individuals, the answer, though equally clear, is negative. Although in the depth of the bust, and in sagittal proportions, the dead pupae are more variable, they are less variable in the length, width, and frontal proportions of the bust. In none of these cases, nevertheless, does the difference exceed its probable error. There is in brief, no selection in variability. And when the facts relating to the antennae are examined, it appears that the survivors exhibit selection in length only with certainty, with possibility in width, and not at all in the variability of the proportionate measure. These statements will be found to be confirmed if the reader examines Table I. alongside Tables II. and III., thus comparing the unselected material with the selected.

B. *Females.*

After examining the facts relating to the female sex, we reach the remarkable conclusion that selection of a particular type occurs *in all eight characters.* In only one instance does the difference between the surviving pupae and the dead pupae fall below the error of the difference. Specifically, the survivors are longer, narrower, and deeper in the bust than the others, and they are also more slender in both frontal and sagittal proportions. Moreover their antennae are longer, wider, and stouter than those of the eliminated pupae. The actuality of selection is still further indicated by the fact that in all characters excepting the proportions of the antennae the variability of the former pupae is far less, and the significance is beyond the range of error due to random sampling. The same general conclusions are reached if we compare the survivors with the unselected material.

## TABLE IV.

*Pupal Period. Selection in Type. Females.*

| Character | Mean; Survivors | Mean; Dead | ($\delta$) Difference | ($\epsilon$) Error of Difference | Proportion of $\delta : \epsilon$ | Selection |
|---|---|---|---|---|---|---|
| Bust, Length ... ... | 19·5039 ± ·0363 | 19·1917 ± ·0443 | +0·3122 | 0·0572 | > 5$\epsilon$ | Certain |
| „ Width ... ... | 12·5949 ± ·0278 | 12·8388 ± ·0338 | −0·2439 | 0·0437 | > 5$\epsilon$ | Certain |
| „ Depth ... ... | 13·6007 ± ·0287 | 13·4250 ± ·0330 | +0·1757 | 0·0437 | > 4$\epsilon$ | Certain |
| „ Frontal Proportions | 64·5727 ± ·0954 | 67·0888 ± ·1079 | −2·5161 | 0·1440 | > 17$\epsilon$ | Certain |
| „ Sagittal „ | 69·7727 ± ·0927 | 70·1111 ± ·1082 | −0·3384 | 0·1424 | > 2$\epsilon$ | Probable |
| Left Antenna, Length ... | 11·6426 ± ·0231 | 11·3833 ± ·0310 | +0·2593 | 0·0386 | > 6$\epsilon$ | Certain |
| „ „ Width ... | 4·3182 ± ·0102 | 4·1283 ± ·0126 | +0·1899 | 0·0162 | > 11$\epsilon$ | Certain |
| „ „ Proportions | 37·1250 ± ·1002 | 36·2667 ± ·0874 | +0·8583 | 0·1329 | > 6$\epsilon$ | Certain |

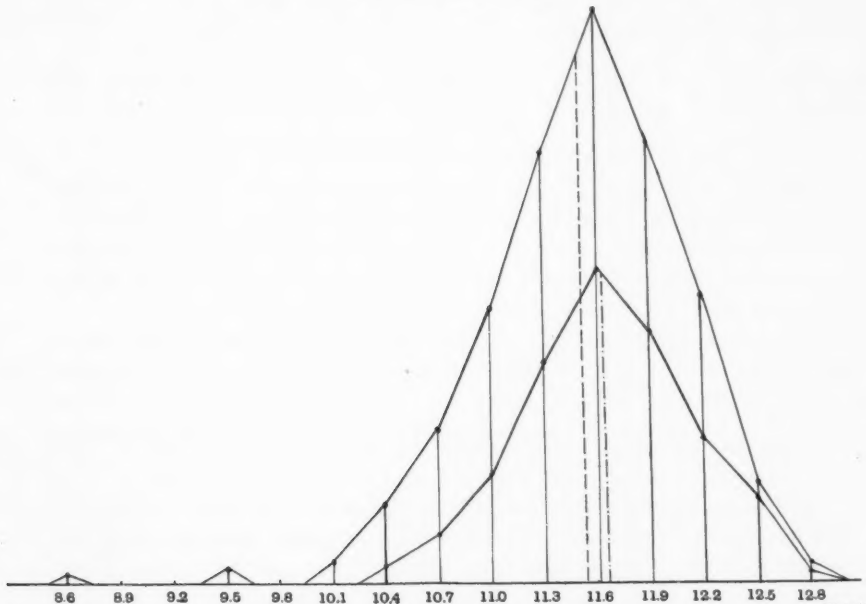
## TABLE V.

*Pupal Period. Selection in Variability. Females.*

| Character | Standard Deviation; Survivors | Standard Deviation; Dead | ($\delta$) Difference | ($\epsilon$) Error of Difference | Proportion of $\delta : \epsilon$ | Selection |
|---|---|---|---|---|---|---|
| Bust, Length ... ... | 0·7150 ± ·0257 | 0·8826 ± ·0313 | −0·1676 | 0·0399 | $> 4\epsilon$ | Certain |
| „ Width ... ... | 0·5477 ± ·0196 | 0·6731 ± ·0239 | −0·1254 | 0·0309 | $> 4\epsilon$ | Certain |
| „ Depth ... ... | 0·5643 ± ·0202 | 0·6567 ± ·0233 | −0·0924 | 0·0308 | $= 3\epsilon$ | Certain |
| „ Frontal Proportions | 1·8770 ± ·0674 | 2·1468 ± ·0763 | −0·2698 | 0·1018 | $> 2\epsilon$ | Probable |
| „ Sagittal „ | 1·8230 ± ·0655 | 2·1535 ± ·0765 | −0·3305 | 0·1007 | $> 3\epsilon$ | Certain |
| Left Antenna, Length ... | 0·4711 ± ·0169 | 0·6177 ± ·0219 | −0·1466 | 0·0276 | $> 5\epsilon$ | Certain |
| „ „ Width ... | 0·2009 ± ·0072 | 0·2517 ± ·0089 | −0·0508 | 0·0114 | $> 4\epsilon$ | Certain |
| „ „ Proportions | 1·9703 ± ·0708 | 1·7387 ± ·0618 | +0·2316 | 0·0939 | $> 2\epsilon$ | Reversed |

One additional fact may be noted, which is that the type selection in the characters of the surviving females is in all cases in the same direction which it takes in the male sex. This correspondence is of decided significance.

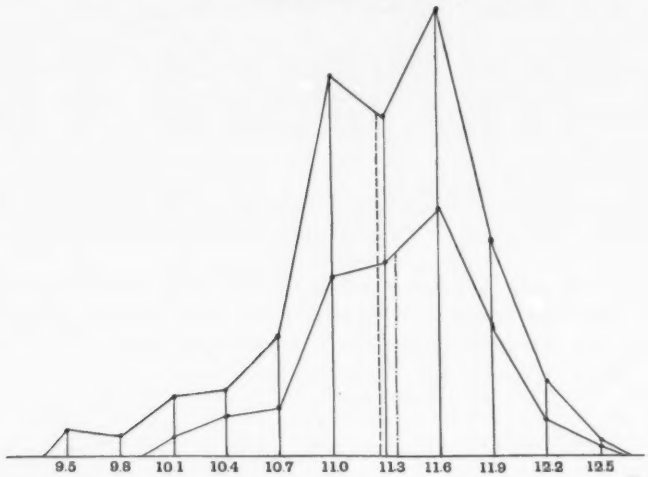
Fig. 2. Selection in Type. Pupal Elimination, Females.
*Left Antenna Length* (*mm.*).



| | 8.6 | 8.9 | 9.2 | 9.5 | 9.8 | 10.1 | 10.4 | 10.7 | 11.0 | 11.3 | 11.6 | 11.9 | 12.2 | 12.5 | 12.8 | Total | m. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All Pupae | 1 | 0 | 0 | 2 | 0 | 3 | 12 | 23 | 41 | 65 | 86 | 65 | 42 | 14 | 2 | 356 | 11·5124 |
| Survivors | | | | | | | 2 | 7 | 16 | 33 | 47 | 37 | 21 | 12 | 1 | 176 | 11·6426 |

Figures 2 and 3 illustrate the general nature of the selection in two cases by graphical representation of the original material and the selected survivors.

Fig. 3. Selection in Type and Variability. Pupal Elimination, Males.
*Left Antenna Length* (*mm.*).




| | | | | | | | | | | | Total | m. | σ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All Pupae | 4 | 3 | 9 | 10 | 18 | 57 | 51 | 67 | 32 | 11 | 2 | 264 | 11·2705 | 0·5549 |
| Survivors | | | 3 | 6 | 7 | 27 | 29 | 37 | 19 | 5 | 1 | 134 | 11·3514 | 0·4686 |

## IV. *Pupal-Imaginal Elimination.*

We may now consider the nature of that reduction which takes place at the time of metamorphosis, and which, although dependent upon pupal abilities, is manifested only when the great changes at this time prove too severe a tax upon the strength of a large number of individuals which were able to survive throughout the earlier period of pupal existence.

It has been stated previously that only 181 out of the 310 survivors produce perfect moths. The rest were imperfect to a greater or less degree, or failed entirely to metamorphose, as follows:

| | Perfect | Slightly Imperfect | Very Imperfect | Non-metamorphosed |
|---|---|---|---|---|
| Males | 97 (72·3°/₀) | 14 (10·4°/₀) | 18 (13·4°/₀) | 5 (3·7°/₀) |
| Females | 84 (47·7°/₀) | 61 (34°/₀) | 20 (11·3°/₀) | 11 (6·2°/₀) |

It therefore appears that the females are the greater sufferers, although if the slightly imperfect individuals be counted with the perfect ones the males and females occur in about the same percentage*.

* In studying the phenomena of sexual selection in *Samia cecropia* it has been found that a male which is imperfect to *any* degree will not copulate, while females which are slightly imperfect may sometimes copulate. These facts will be considered at length in a later communication.

The two characters of total length and weight are available in considering elimination of this period. It will be seen that beside the enquiry into the manifestation of selection of type and variability at metamorphosis, much additional interest arises when the relation between the selective effects of the two different periods of elimination is examined. Treatment of this period must therefore be two-fold.

## TABLE VI.

*Pupal-Imaginal Period. Selection in Type. Males.*

| Character | Mean. Survivors, Perfect | Mean. Survivors, Imperfect | ($\delta$) Difference | ($\epsilon$) Error of Difference | Proportion of $\delta : \epsilon$ | Selection |
|---|---|---|---|---|---|---|
| Length ... ... ... | 26·9329 ± ·0822 | 27·0137 ± ·1493 | −0·0808 | 0·1704 | $< \epsilon$ | None |
| Weight ... ... ... | 1·9464 ± ·0154 | 1·9190 ± ·0307 | +0·0274 | 0·0343 | $< \epsilon$ | None |
| Bust, Length ... ... | 18·3443 ± ·0482 | 18·1190 ± ·1027 | +0·2253 | 0·1134 | $> 1\epsilon$ | Possible (almost probable) |
| „ Width ... ... | 10·8856 ± ·0375 | 10·9702 ± ·0639 | −0·0846 | 0·0740 | $> 1\epsilon$ | Possible |
| „ Depth ... ... | 12·0506 ± ·0345 | 12·0379 ± ·0632 | +0·0127 | 0·0720 | $< \epsilon$ | None |
| „ Frontal Proportions | 59·4691 ± ·1503 | 60·2567 ± ·2590 | −0·7876 | 0·2996 | $> 2\epsilon$ | Probable |
| „ Sagittal „ | 65·7257 ± ·1355 | 66·3648 ± ·2475 | −0·6391 | 0·2821 | $> 2\epsilon$ | Probable |
| Left Antenna, Length ... | 11·3896 ± ·0299 | 11·2514 ± ·0577 | +0·1382 | 0·0649 | $> 2\epsilon$ | Probable |
| „ „ Width ... | 4·6908 ± ·0148 | 4·6676 ± ·0326 | +0·0232 | 0·0358 | $< \epsilon$ | None |
| „ „ Proportions | 41·3351 ± ·1359 | 41·6089 ± ·2416 | −0·2738 | 0·2771 | $< \epsilon$ | None |

## TABLE VII.

*Pupal-Imaginal Period. Selection of Variability. Males.*

| Character | Standard Deviation. Survivors, Perfect | Standard Deviation. Survivors, Imperfect | ($\delta$) Difference | ($\epsilon$) Error of Difference | Proportion of $\delta : \epsilon$ | Selection |
|---|---|---|---|---|---|---|
| Length ... ... ... | 1·2006 ± ·0581 | 1·3465 ± ·1056 | −0·1459 | 0·1205 | $> 1\epsilon$ | Possible |
| Weight ... ... ... | 0·2259 ± ·0109 | 0·2769 ± ·0217 | −0·0510 | 0·0242 | $> 2\epsilon$ | Probable |
| Bust, Length ... ... | 0·7032 ± ·0347 | 0·9265 ± ·0726 | −0·2233 | 0·0804 | $> 2\epsilon$ | Probable |
| „ Width ... ... | 0·5482 ± ·0265 | 0·5765 ± ·0452 | −0·0283 | 0·0523 | $< \epsilon$ | None |
| „ Depth ... ... | 0·5034 ± ·0243 | 0·5701 ± ·0447 | −0·0667 | 0·0508 | $> 1\epsilon$ | Possible |
| „ Frontal Proportions | 2·1939 ± ·1063 | 2·3348 ± ·1831 | −0·1409 | 0·2117 | $< \epsilon$ | None |
| „ Sagittal „ | 1·9768 ± ·0957 | 2·2320 ± ·1750 | −0·2552 | 0·1994 | $> 1\epsilon$ | Possible |
| Left Antenna, Length ... | 0·4375 ± ·0211 | 0·5289 ± ·0408 | −0·0914 | 0·0459 | $> 1\epsilon$ | Possible (almost probable) |
| „ „ Width ... | 0·2173 ± ·0105 | 0·2941 ± ·0230 | −0·0768 | 0·0252 | $> 3\epsilon$ | Certain |
| „ „ Proportions | 1·9828 ± ·0960 | 2·1783 ± ·1708 | −0·1955 | 0·1959 | $< \epsilon$ | None |

A. *Males.*

The pupae which produce perfect moths are found to be slightly shorter than those which fail to do so, and the former are slightly heavier also. In neither case, however, is the difference significant: there is no type selection in these characters.

The data relating to the bust measures are of some interest. The perfect survivors are longer, narrower, and deeper than the imperfect survivors, and they are at the same time more slender in frontal and sagittal proportions; in only the last two does selection appear with any degree of probability. It is highly important to observe that in all of these characters the perfect survivors bear the same relation to the imperfect survivors that the whole group of survivors does to the dead pupae. In brief, elimination of the second period appears to be a continuation of the earlier process of pupal elimination. Therefore the finally selected individuals are by far the longest, narrowest, and deepest, and at the same time the most slender ones of all that entered upon pupal existence.

In the antenna, continued selection appears as regards length, but while broader organs occur in the perfect survivors the difference between these and the others is insignificant. Finally, the antennae of the perfect survivors are slightly more slender, though here, too, the difference is of no account.

Although as we have seen there is no selection indicated in the type values of length and weight, when we compare the indices of variability in the two groups under consideration we find that the perfectly metamorphosing pupae are the less variable. Though this selection is but *possible* as regards the variability of length, a greater significance attaches to the difference between the variabilities in weight. In all the characters of the bust and of the antenna the perfect survivors are the less variable members of the whole group of survivors, but the difference between these and the other pupae is *probably* significant only in bust length, and *certainly* so only in antennal width.

To summarize briefly, we find that type selection at the time of metamorphosis occurs with probability only in the proportions of the bust and in antennal length, while very little selection of variability is evidenced.

B. *Females.*

The pupae which produce perfect moths are slightly shorter, and slightly lighter than the others, selection being *probable* in the first case, and *possible* (almost *probable*) in the second.

While in the males it was found that secondary elimination proceeded along the lines of pupal elimination, the pupae of the other sex show just the opposite relation. Specifically, the perfect survivors are shorter in the bust, and, though narrower as in the previous selection, they are less deep. In the proportionate measures especially they show the reversed nature of selection with the greatest clearness, for they are decidedly stouter in both frontal and sagittal planes with

practical *certainty*, while as a result of the earlier pupal elimination the survivors were found to be the more slender in both characters. Equally anomalous are the facts relating to the antennal characters. A rigid selection is indicated in that the perfect ones have much shorter antennae, and as these are about the same in width in the two groups, a strong selection is shown in antenna proportions, the stouter organs being characteristic of the perfect pupae.

## TABLE VIII.

*Pupal-Imaginal Period. Selection in Type. Females.*

| Character | Mean. Survivors, Perfect | Mean. Survivors, Imperfect | ($\delta$) Difference | ($\epsilon$) Error of Difference | Proportion of $\delta : \epsilon$ | Selection |
|---|---|---|---|---|---|---|
| Length ... ... ... | 30·0595 ± ·1087 | 30·4239 ± ·0727 | −0·3644 | 0·1307 | $> 2\epsilon$ | Probable |
| Weight ... ... ... | 2·8571 ± ·0257 | 2·9173 ± ·0223 | −0·0602 | 0·0340 | $> 1\epsilon$ | Possible (almost probable) |
| Bust, Length ... ... | 19·3309 ± ·0563 | 19·6620 ± ·0440 | −0·3311 | 0·0714 | $> 4\epsilon$ | Certain |
| „ Width ... ... | 12·5750 ± ·0432 | 12·6131 ± ·0347 | −0·0381 | 0·0576 | $< \epsilon$ | None |
| „ Depth ... ... | 13·5691 ± ·0437 | 13·6294 ± ·0373 | −0·0603 | 0·0745 | $< \epsilon$ | None |
| „ Frontal Proportions | 64·8690 ± ·1380 | 64·3044 ± ·1296 | +0·5646 | 0·1892 | $> 2\epsilon$ | Probable (almost certain) |
| „ Sagittal „ | 70·0952 ± ·1351 | 69·4783 ± ·1239 | +0·6169 | 0·1833 | $> 3\epsilon$ | Certain |
| Left Antenna, Length ... | 11·5500 ± ·0362 | 11·7271 ± ·0305 | −0·1771 | 0·0474 | $> 3\epsilon$ | Certain |
| „ „ Width ... | 4·3143 ± ·0152 | 4·3218 ± ·0151 | −0·0075 | 0·0214 | $< \epsilon$ | None |
| „ „ Proportions | 37·4631 ± ·1511 | 36·8152 ± ·1114 | +0·6479 | 0·1877 | $> 3\epsilon$ | Certain |

## TABLE IX.

*Pupal-Imaginal Period. Selection in Variability. Females.*

| Character | Standard Deviation. Survivors, Perfect | Standard Deviation. Survivors, Imperfect | ($\delta$) Difference | ($\epsilon$) Error of Difference | Proportion of $\delta : \epsilon$ | Selection |
|---|---|---|---|---|---|---|
| Length ... ... ... | 1·4748 ± ·0714 | 1·0345 ± ·0514 | +0·4403 | 0·0879 | $> 5\epsilon$ | Reversed |
| Weight ... ... ... | 0·3499 ± ·0182 | 0·3178 ± ·0158 | +0·0321 | 0·0241 | $> 1\epsilon$ | Reversed |
| Bust, Length ... ... | 0·7641 ± ·0397 | 0·6265 ± ·0311 | +0·1376 | 0·0504 | $> 2\epsilon$ | Reversed |
| „ Width ... ... | 0·5869 ± ·0305 | 0·5086 ± ·0252 | +0·0783 | 0·0395 | $> 1\epsilon$ | Reversed |
| „ Depth ... ... | 0·5933 ± ·0308 | 0·5317 ± ·0264 | +0·0616 | 0·0407 | $> 1\epsilon$ | Reversed |
| „ Frontal Proportions | 1·8721 ± ·0974 | 1·8429 ± ·0916 | +0·0292 | 0·1337 | $< \epsilon$ | None |
| „ Sagittal „ | 1·8330 ± ·0953 | 1·7630 ± ·0876 | +0·0700 | 0·1294 | $< \epsilon$ | None |
| Left Antenna, Length ... | 0·4919 ± ·0256 | 0·4339 ± ·0215 | +0·0580 | 0·0334 | $> 1\epsilon$ | Reversed |
| „ „ Width ... | 0·2070 ± ·0107 | 0·2149 ± ·0106 | −0·0079 | 0·0150 | $> 1\epsilon$ | Possible |
| „ „ Proportions | 2·0498 ± ·1066 | 1·5844 ± ·0788 | +0·4654 | 0·1325 | $> 3\epsilon$ | Reversed |

Furthermore reversal of selection with respect to variability appears in some cases with astounding clearness. The perfect survivors are *certainly* more variable in total length, *probably* so in bust length, *possibly* in weight, bust width and bust depth. No significance attaches to the differences in bust proportions. While they are *possibly* more variable in antennal length, and *possibly* less variable in antennal width, the perfect survivors are *certainly* more variable in antennal proportions.

These results stand in the sharpest contrast to those referring to pupal elimination. As the proportionate characters of the bust are involved no less than the absolute values it must be concluded, I think, that the process of pupal-imaginal elimination involves certain factors which do not operate during pupal existence. Hence individuals which could and did survive the conditions of purely *pupal* existence find themselves marked for destruction by the very characteristics which formerly proved advantageous. I regard the reversal on the basis of variability as indicating the same conclusion also. Although discussion of these points may properly be deferred, it may be stated here that the enquiry into the actual basis of the selective processes may lead to a clearer understanding of the apparently conflicting facts.

### V. *The Comparative Variability of Males and Females.*

The question as to which sex is the more variable is of considerable interest in some connections. It is not directly related, however, to the problem which is treated in the present paper, so that the facts may be presented in a brief form without any discussion at this time.

It is clear that it is not possible to determine the relative variability of the two sexes by a simple comparison of the indices of variation for any given character, for with a greater absolute value of any measurement a higher degree of variability is usually associated. A more satisfactory basis for comparison is afforded by the Coefficient of Variation, which is found by dividing the index of variability for any character by the mean value of that character. In order to obtain a convenient whole number, this quotient is generally multiplied by 100. By this means a measure of variability is derived which is independent of the absolute values concerned, though certain mathematical defects, which need not be considered here, may attach to this process.

In the subjoined table (Table X.) are given the coefficients of variability of the ten characters of both sexes, for the whole group (eight characters), for the surviving pupae, and for those which metamorphose perfectly. It will be seen that when the whole group is considered, the males are on the whole more variable than the females, the latter being more variable only in two of the bust measures. Among surviving pupae the male sex is far more variable, being less so in antennal proportions solely. And finally the same sex is the more variable on the whole as regards the body in the third group of perfectly metamorphosing pupae; for

although the females are more variable in the absolute bust measures of length and depth, the other sex is more variable in the significant proportions of the bust. The lower value of the coefficients relating to the antennal characters of the males is extremely suggestive, I think, in view of the function which these organs perform during *imaginal* existence. It is now well known, owing particularly to

TABLE X.

*The Coefficients of Variability of Male and Female Pupal Characters.*

| Character | All. Males | All. Females | Survivors. Males | Survivors. Females | Perfect Survivors. Males | Perfect Survivors. Females |
|---|---|---|---|---|---|---|
| Length ... ... ... | —— | —— | *4·38* | 4·20 | 4·45 | *4·90* |
| Weight ... ... ... | —— | —— | *12·43* | 11·59 | *14·65* | 12·21 |
| Bust, Length ... ... | 4·21 | *4·23* | *4·25* | 3·66 | 3·83 | *3·95* |
| „ Width ... ... | *5·14* | 4·92 | *5·07* | 4·35 | *5·03* | 4·66 |
| „ Depth ... ... | 4·46 | *4·57* | *4·34* | 4·12 | 4·16 | *4·37* |
| „ Frontal Proportions | *4·12* | 3·61 | *3·79* | 2·90 | *3·69* | 2·88 |
| „ Sagittal „ | *3·16* | 2·86 | *3·14* | 2·61 | *3·00* | 2·61 |
| Left Antenna, Length ... | *4·91* | 4·90 | *4·12* | 4·09 | 3·84 | *4·25* |
| „ „ Width ... | *5·95* | 5·43 | *5·15* | 4·66 | 4·63 | *4·80* |
| „ „ Proportions | *5·26* | 5·20 | 4·93 | *5·30* | 4·80 | *5·47* |

the recent work of A. G. Mayer, that the male moth is guided by its sensory antennary organs in finding the female. It is decidedly interesting to find these organs are less variable in the sex for which they are the more useful.

## VI. *Discussion and Conclusion.*

The facts recorded in the foregoing account relate to eight or to ten characters of the pupae of one species of Saturnid moth for one winter season. It is obvious that it would be futile to discuss the bearing of these facts upon the wide question of evolution in any extended form, until the figures here given may be supplemented by others relating to the same and other species of moths, obtained by more detailed studies upon the same and related questions in more abundant material. It is nevertheless necessary to deal briefly with certain aspects of the evidence which has been offered, in order to avoid misconception regarding the main conclusion stated, namely, that there is a real relation between the process of elimination in pupae, and the extent and character of their variation. It may be stated here, that the results of later studies have in no essential way altered the point of view which was arrived at from the consideration of the results of the initial investigation, here recorded.

But before we may examine more closely into the manifestation of selection in the present case, certain possibilities of error demand frank recognition. (1) The number of individuals is smaller than is desirable for the purposes of statistical treatment. It is clear that this error has been allowed for, in so far as each comparison has been based upon the numerical values of the types or of the variabilities *together with their probable errors*, and these are determined by formulae which take full account of the number of cases under investigation; and besides, the occurrence of selection has been asserted only when the difference between comparable indices of variation or between two typical values is in excess of thrice the probable error, certainly a generous allowance. (2) In dealing with graduated values like the various dimensions of the pupa there must always be an error due to the "personal coefficient." Enough individuals have been used to render this error negligible, for according to the law of probability the errors in excess will be offset by errors in underestimation. (3) A far more important objection may be urged against the comparison of the surviving pupae with those which were dead when found; and of course the value of the comparison which has been drawn in the present study cannot be considered as final until definite data are obtained showing the effect that death exerts upon the pupal characters under examination. But the objection can be urged only in certain cases, for the rigid nature of some of the pupal structures, like the antenna, is such that little or no alteration can follow death*; and furthermore it does not militate against the treatment of pupal-imaginal elimination, for all the individuals there considered were alive both at the time of measurement and at the time of metamorphosis. (4) Attention has already been directed to the fact that some of the dimensions used are only approximations, as the length and proportions of the antenna; the former is really the chord of the arc described by the axis of this organ. But it is legitimate to suppose that all chords of a given length represent arcs of the same value on the whole, as those arcs with greater curvature will be offset by arcs with less curvature, and that therefore a chord of a certain value will correspond to a certain average value of the arc. At any rate the differences between comparable determinations of antennal characters in the several groups may be regarded as indicating real differences in antennal structure.

And now, turning to the fundamental question of selection, we must recognize clearly at the outset the essential fact that *elimination does occur* during pupal existence and as well at the time of metamorphosis. Those individuals which reach the end of pupal existence form but a portion of the whole number entering it, and those animals which reach perfect maturity form again a subdivision of the previous group. The fact of reduction in numbers stands unquestioned.

We have seen that those individuals which successfully survive the severe conditions of pupal existence or of metamorphosis are structurally different in

* I have remeasured dead pupae after a two years' interval and have indeed found certain minor differences between the original measurement and the later one. In no case, however, of 70 recently remeasured has the difference led to a change of class of the individuals.

some respects from those which do not, and that the former are on the whole less variable. Consequently we are justified in concluding that elimination proceeds upon a selective basis; for although we must admit that *some* of the eliminated, killed by "chance," may have been just as "fit" as the survivors, yet it is not possible that *all* of them were. Certainly, all of the survivors were "fit." Wherefore the observed differences between any two comparable measurements of the two groups afford tangible determinations of the instability of organization with which unfitness is associated. Natural selection is thus found to exist in the material under consideration. Two questions, however, immediately arise: How far is the process natural? and: In what respects is it selection?

The conditions for pupal elimination were certainly natural in every respect, and it is equally certain that the circumstances attending pupal-imaginal elimination were not the same as those which the pupa meets in nature at the time of metamorphosis. For the pupae in the second case were kept in a cabinet in the laboratory for some weeks and were subjected to warmer and drier air than usual. And yet elimination and selection appear at the second period no less clearly than during pupal existence. As regards the relation which secondary selection bears to primary elimination, we have seen that the two sexes differ in an interesting way. In the male sex the direction taken by selection is the same in both cases. Therefore we may conclude, if the figures relating to the first period be accredited, that the selective agencies were the same during both periods; or to put the matter in another way, we may say that the same physical characteristics of the pupae were tested in the two periods. But in the female sex it was found that, on the whole, secondary selection took place in the reverse direction, and we must conclude either that the conditions which exercise a restrictive effect at the time of metamorphosis are different from those which operate earlier, that in other words the organic test refers to other pupal functions, or else that the unnatural conditions of the laboratory produce a different result from that which would have occurred in nature. The facts are so different in the two sexes, that a direct investigation of this important problem should, and will, be made. Nevertheless, the *fact of primary importance is, not that selection is here natural in the sense that it would have occurred in nature, but that the reduction in numbers proceeds hand in hand with a restriction in certain structural characteristics as regards type and variability.*

The next point to be noted is, that *selection, where it occurs, cannot be based directly upon the characters of the pupa which we have described as showing selection.* The pupa does not "use" its antennae, and no conceivable advantage can accrue to the pupa from a longer, wider, and stouter organ, and yet the survivors have on the whole longer, wider, and stouter antennae. Again, it is difficult to conceive how particular dimensions of the bust can serve advantageously or disadvantageously in the struggle for existence during the pupal period. What, then, is the actual basis for eliminative selection?

We approach the true solution of the problem, I believe, when we realize that we are justified in stating nothing more than that the surviving pupae or those which metamorphose perfectly are of particular forms, and are more conservative with reference to those particular forms than are the individuals which succumb. In short, we may not say that the longer antennae serve the pupa in escaping elimination, but we are justified only in asserting that the surviving pupae have longer antennae. When this statement is made for all the characters which exhibit selection, we see that the essence of fitness is a morphological conservatism with reference to certain values of the dimensions under consideration. Certain it is that those which depart widely from the "fit" type are numbered among the dead.

According to this view, elimination is based upon the general or total efficiency of any individual. And this value is determined by the proper coordination of functional and structural elements. The actual basis for elimination is, in a word, correlation. If this be slight, a condition of less stable equilibrium arises which renders the particular individual less efficient, and which places it among the unfit. In the present case, however, we are dealing with an organism, the pupa, which does not use its structures; so that any lack of proper correlation is attributable to an absence of proper coordination among the formative factors which control the establishment of pupal structures, or by which the imago is constructed upon the pupal basis.

I believe, then, that the test of fitness or unfitness has reference to the physiological and morphological coordination or correlation among the constituent elements of the whole organism, and that any relaxation in either series, in a formative sense or otherwise, results in an instability which may culminate in death and which expresses itself in structural deviation as well as in a higher degree of variability.

Barnard College, Columbia University,
*November*, 1903.

# ON THE LAWS OF INHERITANCE IN MAN.

## II. ON THE INHERITANCE OF THE MENTAL AND MORAL CHARACTERS IN MAN, AND ITS COMPARISON WITH THE INHERITANCE OF THE PHYSICAL CHARACTERS*.

By KARL PEARSON, F.R.S.

### (i) *Introductory.—The Material and its Collection.*

THERE are probably few persons who would now deny the immense importance of ancestry in the case of any domestic animal. The stud-books, which exist for horses, cattle, dogs, cats and even canaries, demonstrate the weight practically given to ancestry when the breeding of animals has developed so far that certain physical characters possess commercial value. A majority of the community would probably also admit to-day that the physical characters of man are inherited with practically the same intensity as the like characters in cattle and horses. But few, however, of the majority who accept this inheritance of physique in man, apply the results which flow from such acceptance to their own conduct in life—still less do they appreciate the all important bearing of these results upon national life and social habits. Nor is the reason for this—or better, one out of several reasons for this—hard to find. The majority of mankind are more or less conscious that man has not gained his pre-eminence by physique alone. They justly attribute much of his dominance in the animal kingdom to those mental and moral characters, which have rendered him capable of combining with his neighbours to form stable societies with highly differentiated tasks and circumscribed duties for their individual members.

Within such communities we see the moral characters developing apparently under family influences; the mental characters developing not only under home training, but under the guidance of private and public teachers, the whole contributing to form a complex system of national education. To use technical

* Being the Fourth Annual Huxley Lecture before the Anthropological Institute, reprinted with the sanction of the Council.

terms, we expect correlation between home influence and moral qualities, and between education and mental power, and the bulk of men too rashly, perhaps, conclude that the home and the school are the chief sources of those qualities on which social stability so largely depends. We are too apt to overlook the possibility that the home standard is itself a product of parental stock, and that the relative gain from education depends to a surprising degree on the raw material presented to the educator. We are agreed that good homes and good schools are essential to national prosperity. But does not the good home depend upon the percentage of innately wise parents, and the good school depend quite as much on the children's capacity, as on its staff and equipment?

It is quite possible to accept these views and yet believe that the moral and mental characters are inherited in either a quantitatively or a qualitatively different manner from the physical characters. Both may be influenced by environment, but the one in a far more marked way than the other. Since the publication of Francis Galton's epoch-making books, *Hereditary Genius* and *English Men of Science,* it is impossible to deny *in toto* the inheritance of mental characters. But we require to go a stage further and ask for an exact quantitative measure of the inheritance of such characters and a comparison of such measure with its value for the physical characters.

Accordingly some six or seven years ago I set myself the following problem: What is the quantitative measure of the inheritance of the moral and mental characters in man, and how is it related to the corresponding measure of the inheritance of the physical characters?

The problem really resolved itself into three separate investigations:—

(*a*) A sufficiently wide inquiry into the actual values of inheritance of the physical characters in man.

This investigation was carried out by the measurement of upwards of 1000 families. We thus obtained ample means of determining both for parental and fraternal relationships the quantitative measure of resemblance.

(*b*) A comparison of the inheritance of the physical characters in man with that of the physical characters in other forms of life.

This has been made for a considerable number of characters in diverse species, with the general result that there appears to be no substantial difference, as far as we have been able to discover, between the inheritance of physique in man, and its inheritance in other forms of life.

(*c*) An inquiry into the inheritance of the moral and mental characters in man.

This is the part of my work with which we are at present chiefly concerned, and I want to indicate the general lines along which my argument runs.

In the first place it seemed to me absolutely impossible to get a quantitative measure of the resemblance in moral and mental characters between parent and offspring. You must not compare the moral character of a child with those of its adult parents. You can only estimate the resemblance between the child and what its parents were as *children*. Here the grandparent is the only available source of information; but not only does age affect clearness of memory and judgment, the partiality of the relative is a factor which can hardly be corrected and allowed for. If we take, on the other hand, parents and offspring as adults, it is difficult to appeal to anything but the *vox populi* for an estimate of their relative moral merits, and this *vox* is generally silent unless both are men of marked public importance. For these and other reasons I gave up any hope of measuring parental resemblance in moral character. I confined my attention entirely to *fraternal* resemblance. My argument was of this kind. Regarding one species only, then if fraternal resemblance for the moral and mental characters be less than, equal to, or greater than fraternal resemblance for the physical characters, we may surely argue that parental inheritance for the former set of characters is less than, equal to, or greater than that for the latter set of characters.

In the next place it seemed impossible to obtain moderately impartial estimates of the moral and mental characters of *adults*. Who but relatives and close friends know them well enough to form such an estimate, and which of us will put upon paper, for the use of strangers, a true account of the temper, probity and popularity of our nearest? Even if relatives and friends could be trusted to be impartial, the discovery of the preparation of schedules by the subjects of observation might have ruptured the peace of households and broken down life-long friendships. Thousands of schedules could not be filled up in this manner. The inquiry, therefore, resolved itself into an investigation of the moral and mental characters of *children*. Here we could replace the partial parent or relative by the fairly impartial school teacher. A man or woman who deals yearly with forty to a hundred new children, rapidly forms moderately accurate classifications, and it was to this source of information that I determined to appeal.

I would refer at once to an objection, which I think is not real, but which I know will arise in the minds of some. It will be said that the temper, vivacity and probity of children is not a measure of the like qualities in the adult. The shy boy at school is not necessarily a shy man on the floor of the House of Commons or confronting a native race on the north-west frontier. Granted absolutely. But what we are comparing is what that boy was at school, with what his brother and sister may have been. We can legitimately compare for purposes of heredity a character of the larval stage of two insects, although that character disappears entirely when both are fully developed as *imago*.

It is possible that some allowance ought to be made for changes during the school period in the mental and moral characters, but I have not found that those characters change very substantially in their percentages with the age of the school children, the bulk of whom lie between 10 and 14. Accordingly, while

the physical characters change during the school period, it did not to a first approximation seem needful to allow for age changes in the mental and moral characters*. Such changes may exist, but they do not appear to be so marked as to substantially influence our results.

In order to carry out this investigation I sought and received aid from the Government Grant Committee of the Royal Society. I have further to acknowledge the assistance I have received, in the task of reduction and computation, from a grant made to my department at University College, by the Worshipful Company of Drapers.

I had deemed it desirable to measure not only the mental and moral characters, but a wide range of physical characters also. These would act as a check on the whole work, for we knew perfectly well what the inheritance of these physical characters might be expected to be. They were further needed as part of a more general investigation into the relationship between the mental and physical characters in man. In order to confine the cost of the inquiry within reasonable bounds, a special head-spanner was devised with the assistance of Mr Horace Darwin of the Cambridge Scientific Instrument Company. This instrument has not the exactness, of course, of the metal callipers of the craniologists, but it affords, carefully handled, a quite adequate means of obtaining the maximum length, maximum breadth and auricular height of the living head. It had further the great advantage that, made in numbers, it cost comparatively little and could be distributed widely among teachers.

Schedules were then, after much consideration and some experimenting, prepared, in which teachers could briefly note the chief characteristics of the children under their charge. These schedules were white for a pair of brothers, pink for a pair of sisters, and blue for a brother and sister. Additional brothers were given on attached white, and additional sisters on attached pink sheets. With the schedules were distributed (*a*) printed directions for the use of the head-spanner; (*b*) general directions as to the estimation of both the physical and mental characters; and (*c*) two additional series of lithographed instructions, which were suggested by special inquiries of the teachers who first began the observations. Copies of the schedule and the general directions are printed in Appendix I.

The material took upwards of five years to collect. Appeal was made through the columns of the educational journals to teachers of all kinds, and our observations were made not only in the great boys' public schools, in the girls' high schools and the grammar schools of the country, but in modern mixed schools, in national and elementary schools of all kinds, in board schools and private schools throughout the kingdom. Some 6000 schedules were distributed and between 3000 and 4000 returned with more or less ample data. I have most heartily to thank the masters

* An additional memoir on the change of mental and physical characters with growth is in course of preparation.

and mistresses of nearly 200 schools in which observations have been made for me. In the midst of arduous professional claims on their time and energy, they have, in many cases at considerable personal inconvenience, recorded and measured the children in their charge, for a purpose only dimly foreshadowed to them. In no case could they realise on the basis of their own 10 or 20 schedules the value of the scientific inquiry to which they were contributing, for its success depended entirely on the combination of tens and twenties into hundreds and thousands, a possibility which even some of my keenest assistants despaired of during the years in which the investigation was in progress. We were, indeed, more than once confronted by an apparent drying up of all conceivable sources of new material. The number of schools is of course immense, but the means of reaching and interesting their masters and mistresses extremely limited*. It is only right and proper to place on record the names of my chief co-operators in this investigation. See Appendix II.

The list in Appendix II. will not only show the class and range of the schools dealt with, but also the great variety of localities which contributed. As far as the United Kingdom contains local races, we have fairly sampled them. Of course one would much prefer to have dealt entirely with a single district with little immigration, and thus have worked wholly within one local race, but a little consideration showed how impossible it was to get material enough for any safe conclusions from such a limited area. It is not one per cent. of teachers who can spare the time, or, being able to spare the time, have the imagination which will induce them to aid in co-operative inquiry of this kind. With the assistance of Mr E. W. Adair an attempt at a limited area was made in the case of Guernsey. But we only succeeded in getting 150 to 200 schedules filled in. These were sufficient to show that a perceptible differentiation in the physical characters existed between Channel Island and English children. No differentiation in the psychical characters could be observed. Accordingly the Guernsey children were not pooled with the others for physical characters, but the material was far too insignificant in amount to justify a separate investigation of the statistical constants†. The influence of local race would undoubtedly make itself felt on our statistics, but taken broadly our constants represent the condition of things in the nation at large, and if any portion of the relationship between brothers and sisters is really due to local race, then we must inquire whether local race is or is not equally influential on the moral and mental characters. My belief

* I must not omit to acknowledge the courtesy of the editors of the *Journal of Education*, *The School World*, *The Schoolmaster* and other educational journals in publishing my appeals.

† While showing a certain differentiation, the general accord between the Guernsey correlations and those of the United Kingdom was remarkable, and extremely satisfactory when we want confirmation of the fact that, within broad lines, we are dealing with general "human" characters and relations, and not with something peculiar to "local race." As an instance I cite the "correlation ratio," $\eta$, a constant determining association,—for the case of head growth with age in girls. Guernsey Girls: $\eta = \cdot 44$; English Girls: $\eta = \cdot 46$. Considering that this Guernsey result is based on 110 cases only, the agreement is remarkable. We are clearly dealing with a constant of human growth in general.

that local race is not largely influential in this enquiry is based fundamentally on the following facts:—

(*a*) The constants of parental heredity deduced from my Family Records, made like the School Observations on members of many English local races, are closely like results found for such selected breeds as race-horses and greyhounds.

(*b*) The Family Records and the School Observations are for the fraternal relationships in excellent agreement.

Hence, while I admit the "local race" problem to be of first-class importance for many anthropological investigations, I do not think that to a *first* approximation, it has had sensible bearing on our present results.

So much may be said here about the nature and manner of collecting our material. The absolute classification and tabling has been a work of great labour. I have to thank in this matter my group of co-workers at University College, more especially Miss Alice Lee, D.Sc.; Miss Marie Lewenz, M.A., Miss E. Perrin, Miss Mary Beeton and Miss Margaret Notcutt have likewise aided me. More recently in the pressure of preparation for this lecture Mrs W. F. R. Weldon and Miss F. E. Cave have come strenuously to my assistance. The chief labour of computing has fallen upon Dr Alice Lee, but a considerable number of the tables have been re-done or revised by myself. Miss F. E. Cave has either computed, or re-worked and computed, a considerable number of the head measurements and growth with age tables (not here published) necessary for the reduction of head measurements to a uniform age. To Miss M. Lewenz I owe aid in the computation of the health, ability and athletics data. In short, although *I* may be giving the Huxley Lecture, the work is essentially the result of a co-operative investigation extending over a number of years, and depending upon a body of collaborators, without whom it would have been quite impossible to deal with, much less to collect, the extensive data on which my results entirely depend.

### (ii) *Nature of the Theory Applied.*

Much of what I have to say upon this point would not be new to those who have examined recent biometric work, and some of it would not be intelligible except to the trained mathematician. Still we must strive in broad lines to see how the work has been done, and above all, to justify our treatment of the psychical characters.

To illustrate the method I will examine a little at length the degree of resemblance of brothers in a physical character. I choose cephalic index and this for two reasons:—

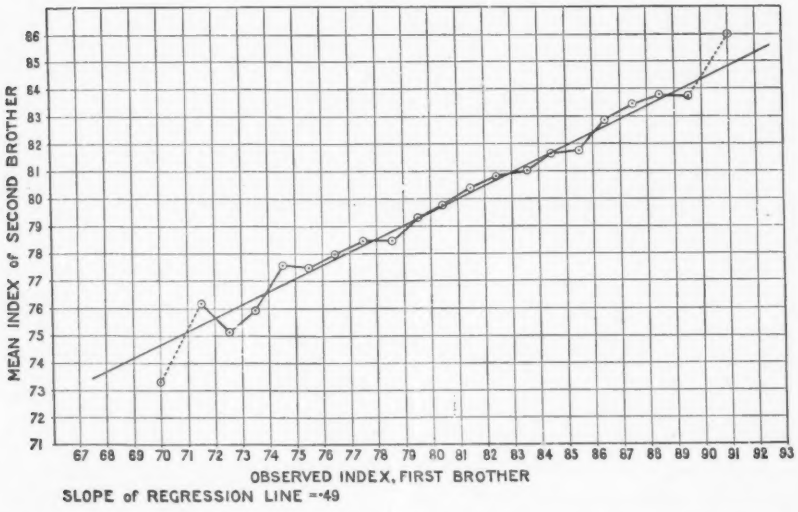
(*a*) Because from the first few years of life onwards the cephalic index scarcely changes with growth.

I have not yet investigated my own school data from this standpoint, but I have every confidence in the care taken by the late Dr W. Pfitzner in his elaborate system of measurements, and the above is the conclusion he reaches*.

(*b*) Several great authorities have recently stated that they do not "believe" in the cephalic index, i.e., consider it of small value for anthropometric purposes.

In Table E (i), Appendix III., we have the cephalic index given for 1982 pairs of brothers. This table is, I hope, perfectly intelligible. Taking the boys, for example, with cephalic indices between 74 and 75, these boys had 78 brothers who were distributed according to the arrangement in the column headed 74 to 75. Brothers are not alike in cephalic index, but distributed with a considerable range of variation. We now take in the usual way the arithmetic mean of this array of brothers, and find it to be 77·45. The average brother of a boy with cephalic index = 74·5 has an index of 77·45. This is the phenomenon of regression towards the general population mean (78·9) as discovered by Francis Galton. Now turning to Diagram I. we plot to 74·5, the mean brother 77·45, and doing this for all arrays

DIAGRAM I. *Resemblance of Brothers in Cephalic Index.*




we get the series of points there exhibited. You will see at once that they lie almost exactly on a straight line. This is the well-known regression line. If

* *Zeitschrift für Morphologie u. Anthropologie*, Vol. I. 1899, p. 372. My schoolboys from all districts give 78·9; 3000 criminals of adult age from all districts give 78·5—there is not much room for sensible growth change in these juvenile and adult results. Observations of my own on actually the same growing children, show very small, if any change.

DIAGRAM II. *Resemblance of Sister's Span to Brother's Forearm.*

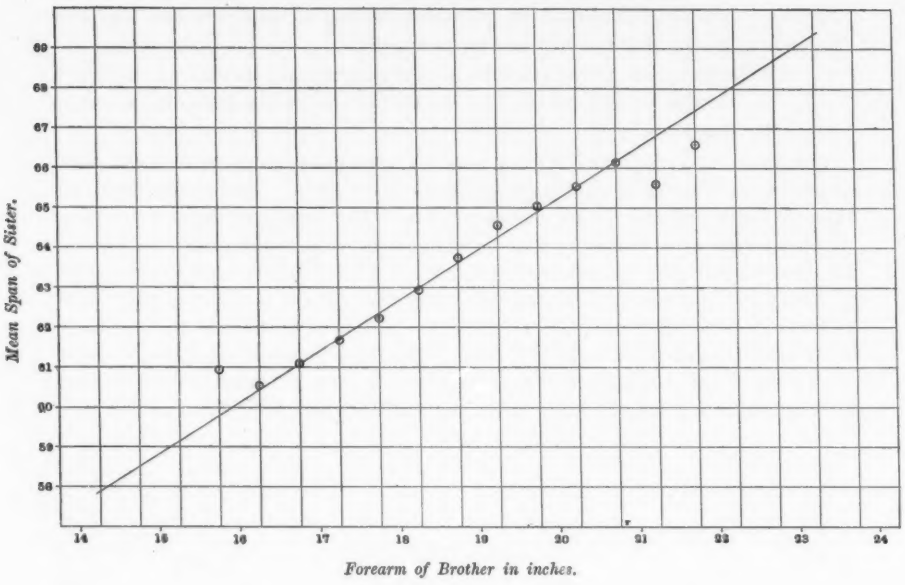
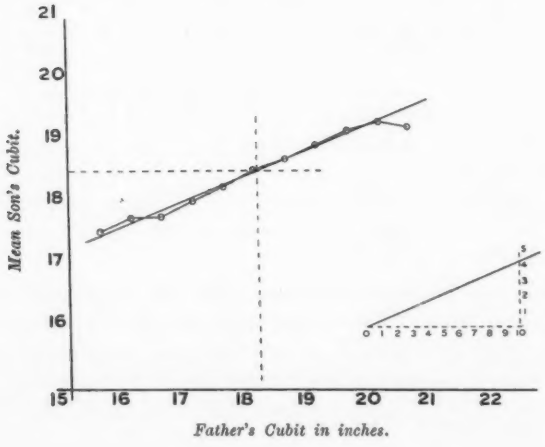


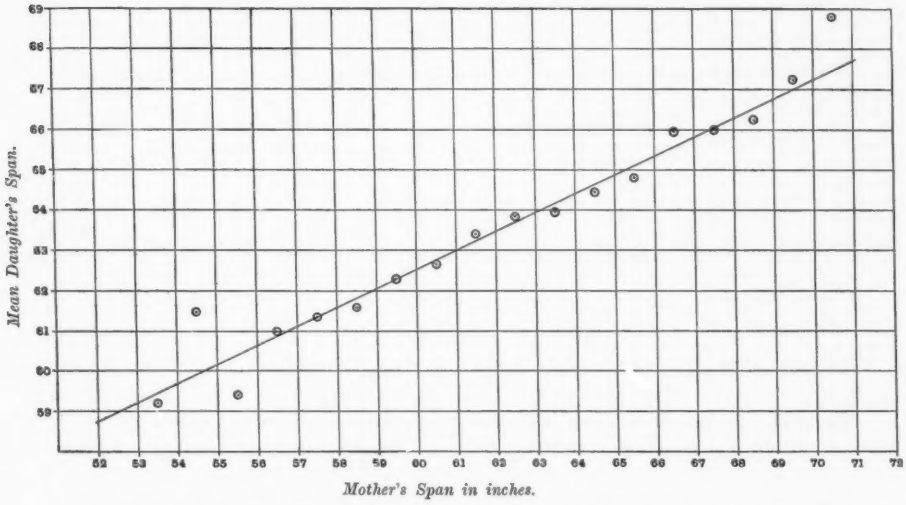

DIAGRAM III. *Resemblance of Father and Son in Cubit.*



that line had a slope of 1 in 1, the brother of 74·5 would have a mean brother of 74·5 cephalic index. If it had no slope at all the brother of 74·5 would have a brother like the mean of the general population. In the one case we have absolute resemblance, in the other case no resemblance at all. The actual degree of resemblance, our brothers being equally variable, is measured by the steepness of this regression line. In our case that steepness is ·49, almost ·5 or 1 in 2. That is the measure of fraternal resemblance in brothers for cephalic index—the correlation between brothers as we term it.

Now we have learnt two great features of inheritance in man. First, that the points in Diagram I., within the limits of observation, are on a line, and secondly, that the slope of this line is about ·5. Are these results true for characters other than the cephalic index? Undoubtedly for all the physical characters yet worked out in man. Here are additional illustrations: see Diagrams II.—IV.* We cannot hesitate about the regression line being essentially linear. Has it for brethren usually a slope of about ·5?

DIAGRAM IV. *Resemblance of Mother and Daughter in Span.*




In Table I. are given my observations on some 1000 families for adult brothers and sisters. You will see that the steepness of the regression line is essentially about ·5.

In Table II. are given my observations on the head measurements of school children. We note at once precisely the same convenient number ·5.

* Diagrams II. and IV. are reproduced from the memoir by the author on "Inheritance of the Physical Characters in Man," *Biometrika*, Vol. II. pp. 362–3, and Diagram III. from an article in the same journal, Vol. II. p. 216, on the "Law of Ancestral Heredity."

I think we, therefore, may safely conclude that for the measurable physical characters in man, we have a quite definite regression line, and that it ascends 1 in 2.

TABLE I.

*Inheritance of the Physical Characters.*

Records of Adults.

| Character. | Correlation. | | |
|---|---|---|---|
| | Brothers. | Sisters. | Brothers and Sisters. |
| Stature... ... ... ... | ·51 | ·54 | ·55 |
| Span ... ... ... ... | ·55 | ·56 | ·53 |
| Cubit ... ... ... ... | ·49 | ·51 | ·44 |
| Eye Colour ... ... ... | ·52 | ·45 | ·46 |
| Mean ... ... ... ... | ·52 | ·51 | ·49 |

TABLE II.

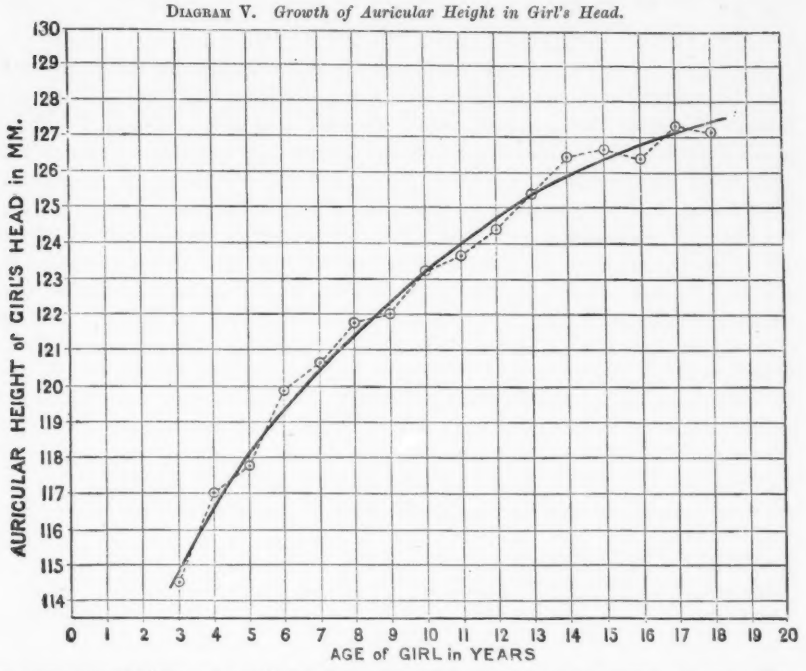
*Head Measurements on School Children.*

| Pair→ | Brother-Brother. | | | Sister-Sister. | | | Brother-Sister. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Characters. | Mean. | S.D. | Correlation. | Mean. | S.D. | Correlation. | Mean. | | S.D. | | Correlation. |
| | | | | | | | B. | S. | B. | S. | |
| Cephalic Index.. | 78·92 | 3·314 | ·4861 | 78·29 | 3·988 | ·5360 | 78·72 | 78·96 | 3·237 | 3·382 | ·4265 |
| Head Length (12 years) | 184·52 | 6·454 | ·5041 | 180·22 | 6·346 | ·4251 | 183·82 | 179·20 | 6·563 | 6·510 | ·4575 |
| Head Breadth (12 years) | 145·23 | 5·739 | ·5925 | 140·21 | 6·547 | ·6208 | 144·24 | 140·59 | 5·975 | 5·708 | ·5419 |
| Head Height (12 years) | 127·19 | 6·479 | ·5537 | 124·07 | 6·868 | ·5237 | 127·36 | 124·80 | 7·031 | 6·226 | ·4897 |
| Mean. | — | — | ·5341 | — | — | ·5264 | — | — | — | — | ·4789 |

S.D. = Standard deviation, the measure of the variability of the observed character.

It is proper before I go further, to explain how the results for resemblance between brothers and sisters of different ages in head measurements have been made. In the first place a growth curve for each sex and for every measurement was drawn; this growth curve simply consists in plotting the average size of head of a child of given age to that age. Diagram V. represents the growth

DIAGRAM V. *Growth of Auricular Height in Girl's Head.*



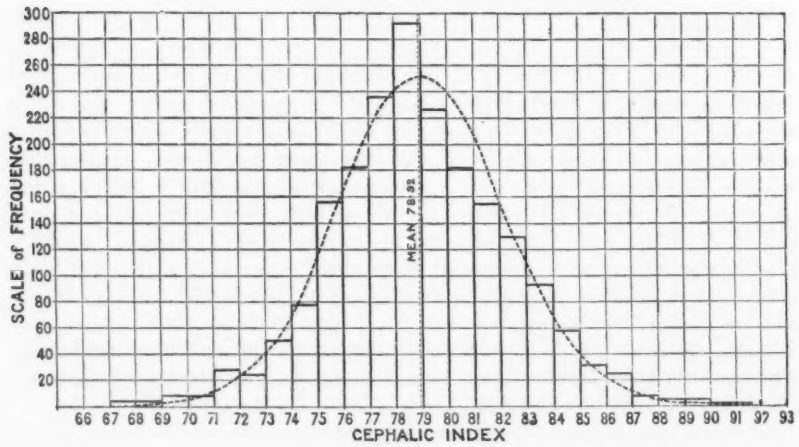

of auricular height of head of the mean girl from 4 to 19 years of age. The observation points are then smoothed and we obtain the mean growth curve. I cannot stay to discuss these mean growth curves now, but it must be clear that they give us a method of ascertaining the mean head growth of a child from any one year of its life to any other. Now all children do not grow in the same manner, but as we are dealing with average results we shall obtain a reasonable measure of growth by using the growth curve of the mean child. By means of six growth curves like that shown, the length, breadth, and height of every child's head was reduced to the dimensions it would most probably have at the age of 12 years. Thus we were able to compare the likeness in head measurements of brothers at the *same* standard age. This is the method by which the inheritance of head length, breadth, and height, given in Table II., was deduced*.

* By a much more elaborate investigation in multiple correlation I found for resemblance between brothers in head length ·54 (see *R. S. Proc.* Vol. 71, p. 294). The growth correlation not being absolutely linear, I am not sure that that value is better than the ·5 of the present simpler method.

Now what are we to understand by "believing" or "not believing" in the value for anthropological purposes of any character? Surely the main point for such purposes is the question of whether or no it be inherited and have small variability within the group? I don't think if we look at Table II. we shall find the cephalic index worse than other head measurements, especially if we stick to one sex. It has an inheritance coefficient of about ·5, just what for practical purposes we have found for other physical characters.

So far we have seen surprising uniformity in the inheritance of the measurable physical characters. How are we to extend our results to physical characters not capable of accurate measurement, and to psychical characters? Clearly the whole problem turns on this: Can we find the steepness or slope of this regression line without all the paraphernalia of the correlation table and the means of arrays? The answer is: Yes; providing we assume a certain distribution of frequency for the character in human populations. This distribution of frequency is given by the Gauss-Laplacian normal curve of deviations from the mean. Grant this distribution, and by very simple classifications indeed we can determine the steepness of the regression line. Now the problem before us is the following one:—Is this assumption legitimate? It is certainly not true for organs and characters in *all* types of life. But it really does describe in a remarkable manner the distribution of most characters in mankind. We have shown that within the limits of random sampling, it is very true for a great variety of characters in the human skull*. Dr Macdonell has demonstrated it also for measurements on criminals, and you can be fairly convinced of its suitability by looking at one or two diagrams. Diagram VI. gives the distribution of nearly 2000 boys in cephalic

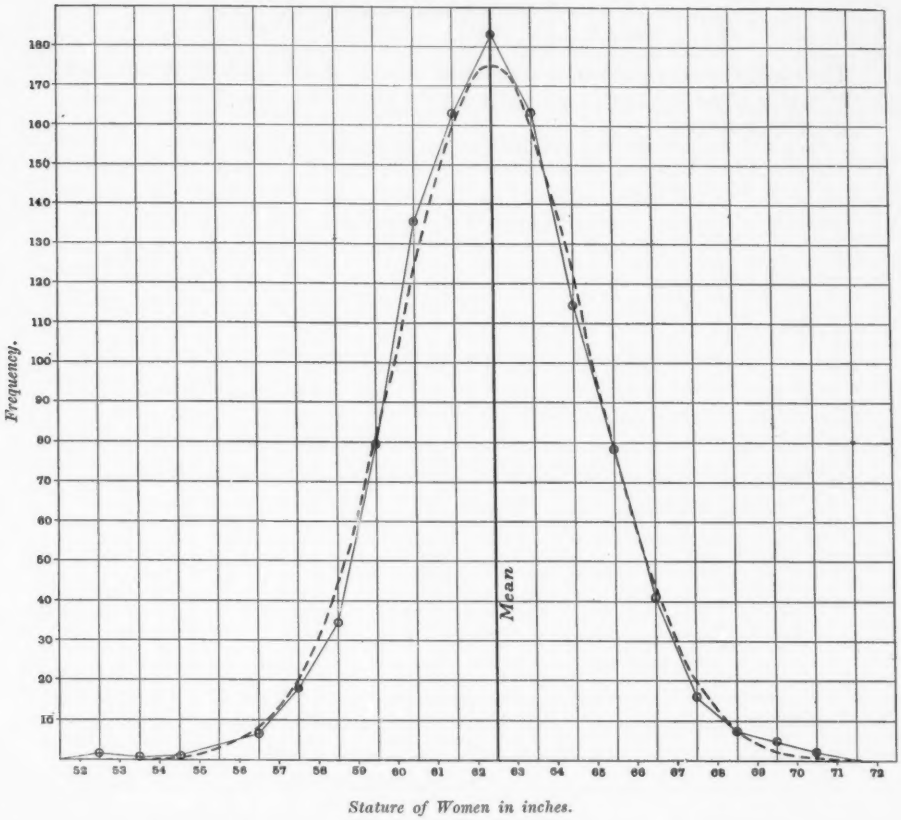
DIAGRAM VI. *Distribution of Cephalic Index in* 1982 *Boys.*




* *Biometrika*, Vol. I. p. 443.

index; Diagram VII. the distribution of stature in 1000 women; Diagram VIII. the distribution of head breadth in 3000 criminals*. I should be the last to assert that no human characters can be found that do not diverge sensibly from this Gaussian distribution. But I believe they are few, and that for practical purposes we may with nearly absolute safety assume it as a first approximation to the

DIAGRAM VII. *Distribution of Stature in Women.*




actual state of affairs. This being once granted we can obtain the slope of our regression line by an exceedingly simple process. We can make a mere classification of the following kind, say, into boys with breadth of head below 145 mm.,

* Diagram VII. is from the paper on the "Inheritance of the Physical Characters in Man," *Biometrika*, Vol. II. p. 364, and Diagram VIII. from Dr Macdonell's memoir in this journal, Vol. I. p. 184.

and boys with breadth of head above 145 mm. For example, here is a simple classification of 2022 pairs of brothers by this process:—

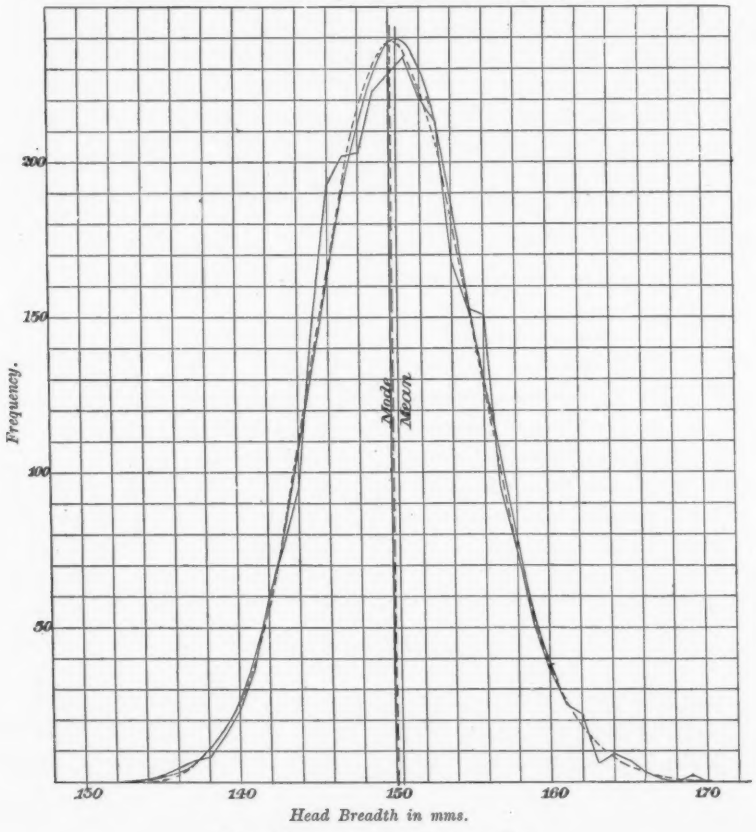
*Breadth of Head.*

First Brother.

| Second Brother. | Below *145* | Above *145* | Totals |
|---|---|---|---|
| Below *145* ... | 635·5 | 307 | 942·5 |
| Above *145* ... | 307 | 772·5 | 1079·5 |
| Totals | 942·5 | 1079·5 | 2022 |

The result is precisely the same as dividing this ring model (*exhibited at the lecture*) by a pair of rectangular planes and counting up the number of rings in each of the four spaces.

DIAGRAM VIII. *Distribution of Head Breadths in* 3000 *Criminals.*




Normal curve given by continuous line.

Now from such a division the mathematician can deduce* the slope of the regression line on the assumption of normal distribution. Here, to give us confidence, are the results for head breadth and height in boys, which were worked out both ways:—

*Resemblance of Brothers.*

| | Long table | Fourfold division |
|---|---|---|
| Head Breadth ... ... | ·59 | ·58 |
| Auricular Height ... | ·55 | ·56 |

For practical purposes these results are identical.

Accordingly let us assume this fourfold division will work, and investigate by means of it a non-quantitatively measurable physical character in man. I choose *Health* as an example. In Table A (i), Appendix III., we have the distribution of health in a population of 1918 school boys, and in Diagram IX., we have the arrangement of the same material, supposing it to follow a normal curve. My five classes were (i) *Very Strong*; (ii) *Strong*, being here used not in the sense of physically strong, but of *Robust*; (iii) *Normally Healthy*; (iv) *Rather Delicate*; and (v) *Very Delicate*. You will see that the "modal" boy is somewhat on the normally healthy side of robust, but that the *Very Robusts* are more numerous than the *Very Delicates* and the *Robusts* than the *Delicates*. I think the scale is not without suggestiveness even as a general health distribution for the population at large. It gives us for the first time an exact measure of the ranges of delicacy and robustness in terms of normal health.

Now I applied this scale to the relation between brothers in health character. I plotted up at the mean of robust boys, a length on this scale equal to the mean on the same scale of the array of brothers of these robust boys; there was naturally a regression towards normal health. I did this for all the possible five arrays†, and I thus obtained the five points given in Diagram X. You will see at once that our five points lie quite nicely distributed about the regression line as found by the fourfold division method discussed above. In other words, there can be little doubt that the general health of boys is a character which closely follows the normal law of distribution, and has a true line of regression. The slope of that line is ·52, or we may safely say that general health in the community is inherited in precisely the same manner as head-measurements or body-lengths.

I now come to the fundamental idea of my comparison of the psychical and physical resemblance of brothers. Suppose we assume that moral and mental qualities in man, like the physical, follow a normal law of distribution, and that

* Mathematical Contributions to the Theory of Evolution. VII. "On the Correlation of Characters not Quantitatively Measurable," *Phil. Trans.* Vol. 195, A, pp. 1—47.

† For the benefit of the mathematical statistician, I may say that I used the modal group of each sub-array to determine its mean and standard deviation in terms of those of the scale for the whole population.

DIAGRAM IX. *Distribution of Health in* 1918 *School Boys.*

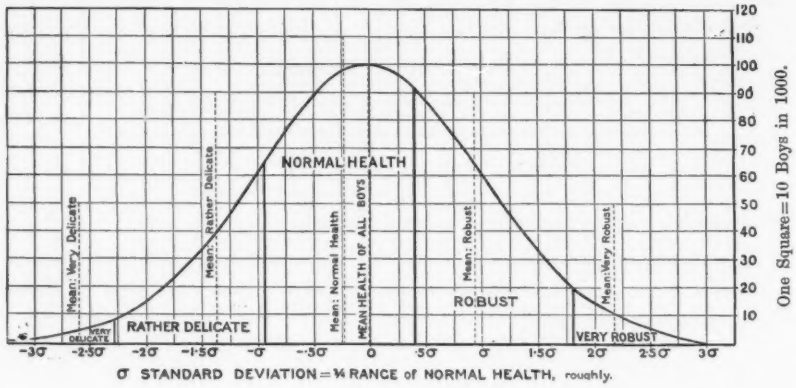
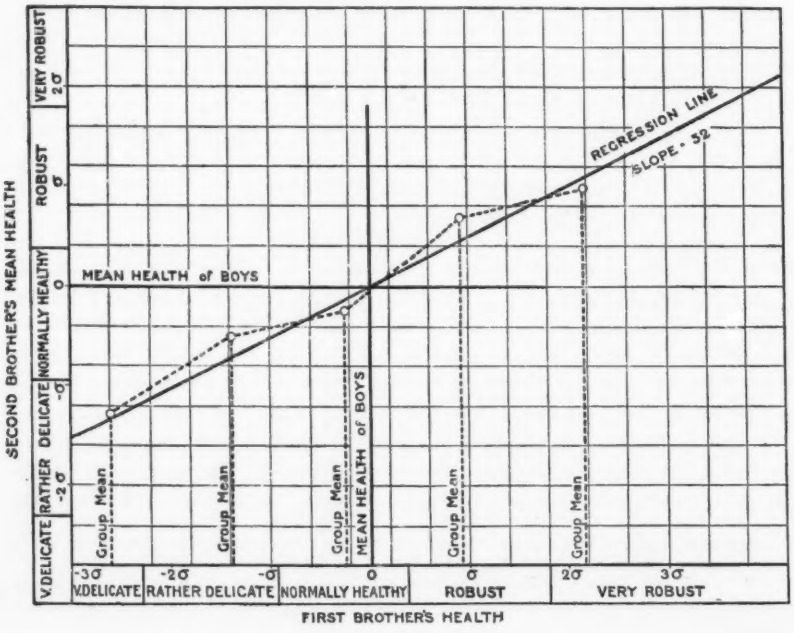



DIAGRAM X. *Resemblance in General Health of* 1918 *Pairs of Brothers.*



the regression is linear. What results shall we obtain by thus assuming perfect continuity between the physical and the psychical? No doubt the drums will begin to beat the tattoo, we shall hear talk of the hopeless materialism of some men of science. But to use Huxley's appropriate words: "One does not battle with drummers." I cannot free myself from the conception that underlying every psychical state there is a physical state, and from that conception follows at once the conclusion that there must be a close association between the succession or the recurrence of certain psychical states, which is what we judge mental and moral characteristics by, and an underlying physical confirmation be it of brain or liver. Hence I put to myself the problem as follows:—Assume the fundamental laws of distribution which we know to hold for the physical characters in man, and see whither they lead us when applied to the psychical characteristics. They must: (*a*) Give us totally discordant results. If so, we shall conclude that these laws have no application to the mental and moral attributes. Or, (*b*) Give us accordant results. If so, we may go a stage further, and ask how these results compare with those for the inheritance of the physical characters: are they more or less or equally subject to the influence of environment? Here are the questions before us. Let us examine how they are to be answered. As an illustration I take *Ability in Girls*. I measured intelligence by the following seven classes. (i) *Quick Intelligent*; (ii) *Intelligent*; (iii) *Slow Intelligent*; (iv) *Slow*; (v) *Slow Dull*; (vi) *Very Dull*; and a quite distinct category (vii) *Inaccurate-Erratic*. Some explanation of these terms is given in Appendix Ia., which contains the general instructions for observation, and the terms themselves were practically formulated by a schoolmaster of considerable pedagogic and psychological experience.

My next stage was to ask two or three different teachers in several schools to apply the classification to 30 to 50 pupils known to each of them. The classifications were made quite independently, often by teachers of quite different subjects, and a comparison of the results showed that 80 to 85 per cent. of the children were put into the same classes by the different teachers, while about 10 per cent. more only differed by one class. This gave one very great confidence not only in the value of this scale, but of other psychical classifications when used by observant teachers. The next stage was to obtain exactly, as in the case of *Health*, a general scale of intelligence*.

Diagram XI. gives the normal distribution of intelligence in a population of 2014 girls. It is a curious, if a common result of experience, to find that the modal ability is on the borderland between the *Intelligent* and *Slow Intelligent*. We have here for the first time a quantitative scale of intelligence, and we can at once apply it to the problem of the degree of resemblance between sisters as regards ability. Just as in the case of *Health*, all the girls of a given class are taken, say the *Slow Intelligents*, and at the average value of this class, is plotted upon this scale of intelligence, the average value of the intelligence of the sisters of these girls on

* I should say at once that the *Inaccurate-Erratics* turned out a surprisingly small class, a fractional per cent. of the community, and that they were not further dealt with.

DIAGRAM XI. *Distribution of Intelligence in 2014 Girls.*

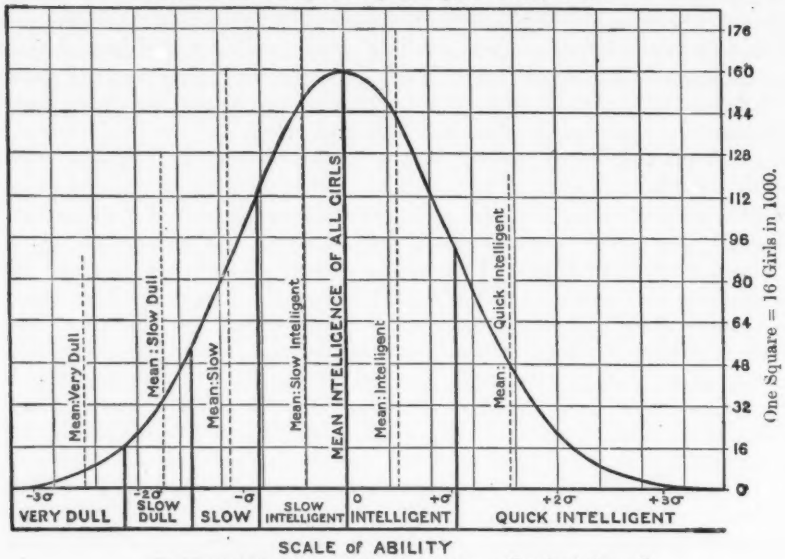
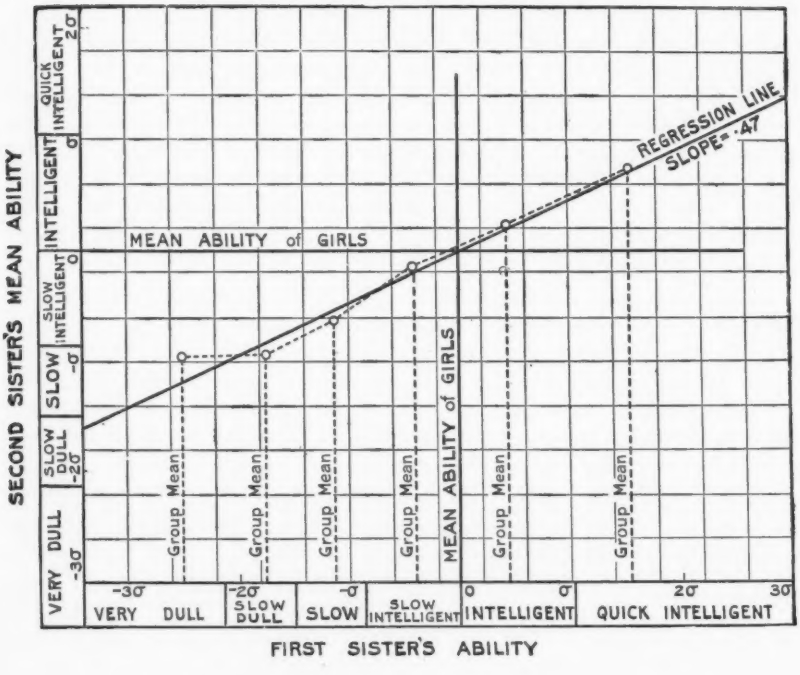



DIAGRAM XII. *Resemblance of Sisters in Ability.*



the same scale. We thus obtain the six points of Diagram XII., all well within the limits of random sampling, lying on the straight line found from the fourfold division of the data. The slope of this line is ·47 or 47, close to 50, in the 100. There can, I think, be small doubt that *Intelligence* or *Ability* follows precisely the same laws of inheritance as *General Health*, and both the same laws as *Cephalic Index*, or any other physical character.

In precisely the manner indicated here all the other physical and psychical characters recorded may be dealt with. But before we sum up our results for the slopes of all the lines thus investigated, it is most essential to make, especially to an anthropological audience, some remarks on the manner in which the individual physical and mental characters have been treated.

### (iii) *Remarks on Individual Characters dealt with.*

#### *Physical Characters.*

(A) *Health.*—We have already seen how this was recorded. In order to deduce the correlation two fourfold tables were made. In the one the division was made between *Delicate* and *Normally Healthy*, in the other between *Normally Healthy* and *Strong*. Theoretically the fourfold divisions ought to be made everywhere where possible, and the weighted mean taken of the results to smooth out irregularities, but the labour is too great for practical purposes, and we must content ourselves with a few simple divisions.

(B) *Eye Colour.*—Our division was into light, medium, dark. The eyes corresponding to these classes are stated in the general instructions. See Appendix Ia. For practical purposes the scale is one of the intensity of yellow pigmentation*. In this case, remembering that "medium" is rather a vague class, the fourfold division was taken at each of the four corners of the medium-medium category and the mean correlation of the four resulting tables taken to represent the actual correlation in eye colour.

(C) *Hair Colour.*—This is a character concerning which we sadly need a combined investigation on the part of a physiologist, a chemist, and an anthropologist. In saying this, I am not forgetting the pioneer work of Mr H. C. Sorby published in the *Journal* of this Institute†. I do not feel perfectly convinced that we have really got to the number of pigments involved. Even if we have, and there be just two, it by no means follows that our nomenclature enables us effectually to separate hair possessing these pigments in various degrees, still less to place in their right position in any scale the cases of blended pigments. Assume by way of illustration

* Blue is to be considered as an absence of pigmentation.

† *Jour. Anthr. Inst.*, Vol. VIII. 1878, pp. 1—14.

*only*, that there existed two pigments, black and red. We might by placing red at one end of the scale and black at the other, obtain a single scale which would really be a double one, i.e., a scale of diminishing amounts of black pigment from one end, and of red from the other. In the one case the fairs are classed with red as marking an absence of black pigment and in the other case with the darks as marking an absence of red. Fourfold divisions of this table would then give the correlation between brethren either in the amount of red pigment or in the amount of black pigment. Unfortunately the observer comes across—besides a very deep red type of hair which seems to be pure red, and which shades, if enough individuals are taken, continuously away from "fair reds"—another red, a "dark red," which I found frequently described as "brown red" or "dark brown red," and which seems to be a blend of the red and dark pigments. The existence of these brown reds seems to me the difficulty of the single scale arrangement. It is on this account that some hair scale makers have placed the reds alongside the browns, but this appears to misplace the "fair reds" and "pure reds." I am at present working on the problem of a practical hair scale, and I am not at all certain that something corresponding to the artist's conception of "value" is not what we want, if we are to use hair colour as a character for investigations about inheritance. I merely refer to this method because I consider these hair colour results somewhat unsatisfactory and subject to revision and reclassification. There is another point also to which I must refer. I have found a distinct growth in children's hair colour with age. This, of course, has been recognized in a general way, but our data supply, as soon as we have settled our scale, the quantitative measure of it. Hence, exactly as in the case of head measurements, we ought really to allow for the growth change in hair before measuring the resemblance of brothers. Allowance for this growth, to judge from the effect of growth in other cases, might easily change the value of the correlation by 10 to 15 per cent. I hope to return to the problems of scale and growth in hair colour; meanwhile I would describe what I have done. The hair correlation tables have been worked out in four different ways, namely, by forming fourfold tables at each corner of the "brown-brown" category. By doing this I have endeavoured to allow for the position of the red-browns, which were classified under reds, i.e., whenever a division comes for the fourfold table between brown and dark, it is immaterial whether the reds are placed beyond the fairs, between fairs and browns, or between browns and darks. The results given for hair are the means of the four correlations found by working out the tables in four different ways. I believe on any system of "value*" my results will be approximately correct, but it would still need correction for growth, i.e., a sensible darkening in the fifteen years of life covered by our observations. On the whole, I publish the hair colour results with reservations†.

* I hope shortly to be able to publish photographic measures of "value" in hair colour.

† I think since writing the above I have surmounted the difficulty of scale orders by applying the new method of contingency, which completely dispenses with any scale order: see *Drapers' Company Research Memoirs*, I. "On the Theory of Contingency and its Relation to Association and Normal Correlation." (Dulau and Co., Soho Sq., London.)

(D) *Curliness of Hair.*—Our three categories were smooth, wavy, curly. The results are the means of two computations, first with the division between smooth and wavy, and then with the division between wavy and curly.

(E) *Cephalic Index.*

(F) *Head Length.*

(G) *Head Breadth.*

(H) *Auricular Height.*

The method of investigating the degree of resemblance in these characters has been already referred to. We may note that, in all cases, the order of intensity in resemblance is head breadth, auricular height and head length. I confess to believing that some of this is due to greater difficulty in getting a true head length, than a true breadth or height, but I do not believe that this is the sole source of the divergence. I shall touch on this subject on another occasion when I come to deal with growth of head in children, meanwhile I would say that it appears to me that a pause arises in the growth of head length which is not perceptible, or at least not so perceptible, in the case of the growth of breadth or height. I should not be surprised to find that the on-coming of puberty affects the growth of head length differently from the growth of head breadth or height, and that a comparison for this character of brothers or sisters, one of whom has and the other of whom has not reached the age of puberty, may to some extent affect our results. This influence would not be fully allowed for by growth curves, as the age of puberty, especially in girls, seems to vary largely, even in members of the same family.

(I) *Athletic Power.*—While I have worked with only eight physical and eight mental characters, I have an additional character which it is needful to refer to here, and which it is difficult to class as purely physical. I mean athletic capacity. We may define the athletic individual as one who is not only keen on sports and games, but who is capable in them. This denotes a training and a *mental control* of hand and eye, and approaches psychical efficiency*. It might therefore be a problem to determine in which class of characters the athletic should be placed. The results, however, of dealing with athletics are from the standpoint of inheritance abnormally high. An examination of the schedules led me at once to the conclusion that much of this resemblance was wholly spurious. Certain schools, boys' public schools and the larger girls' schools, pride themselves on an athletic reputation; hence two brothers or two sisters at such schools are usually returned as an athletic pair. On the other hand, schools without an athletic reputation are too liable to return the two members of a pair as non-athletic, the teachers having little or no knowledge of the game capacity of their pupils. Hence arises the high value of resemblance in athletic power between the members of a pair of brothers or a pair of sisters. This resemblance is largely, perhaps 40 to 50 per cent.,

* This is confirmed by the high correlations I have found to exist between athletic capacity and many psychical characters.

a result of a differentiation between the class of schools in which athleticism is a cult and the class in which it is not—the town or board school with little playground and no game training.

To complete the demonstration of this conclusion we need only turn to the mixed schools, whence our brother-sister pairs are drawn. These schools do not exhibit the athletic cult on the same scale, and we get quite a fair and reasonable value for the resemblance of brothers and sisters in athletic power. To obtain the correlation the fourfold division was taken between the athletic and non-athletic.

*Psychical Characters.*

(J) *Vivacity.*

(K) *Assertiveness.*

(L) *Introspection.*

(M) *Popularity.*

(N) *Conscientiousness.*

In all these five psychical characters, our schedule admitted of only three possibilities, i.e., the cross must be placed in the space allotted to either contrasted character, or on the dividing line between, marking a "betwixt and between" state of affairs. Our tables were prepared with a ninefold system of categories including a "betwixt" column and row. The "betwixts" were not, however, very numerous, and they were then halved or quartered as the case might be into the adjacent groups to save the great labour of working with four fourfold tables and averaging the four results.

(O) *Temper.*—Our categories were: *Quick-tempered, Good-natured,* and *Sullen,* with the usual system of "betwixts." In a very few instances sullen children were recorded who had occasional outbursts of quick temper. In this classification accordingly, some of the like difficulties arise that we have noted in the case of hair colour. To surmount these, first a division was made between quick temper and good temper, and the correlation found from the fourfold table thus reached. Secondly, the sullen were thrown in with the quick, and the whole classed as *Bad tempered* in contrast to *Good tempered.* In the first case we are measuring a certain phlegmatic character, in the second rather the extent of self-control. But the two divisions led to very sensibly the same results. Thus for girls we have the correlations:—

Division between Quick and Good temper: ·49.

Division into Good and Bad (Quick and Sullen) tempers: ·50.

The mean of the two results was then taken as a measure of correlation in the matter of temper.

(P) *Ability.*—We have already (p. 147) discussed this character at some length. All that seems necessary to add is that the division for the fourfold table was taken between *Intelligent* and *Slow Intelligent.*

(Q) *Handwriting.*—Some persons may be inclined to question whether this character is properly placed in the psychical class. Is it really a largely muscular characteristic? Personally I do not think it desirable to draw very rigid lines between the physical and psychical, and the present inquiry has much strengthened that opinion. But we have gone far further with handwriting than is obvious on the face of this paper, which is confined to inheritance; and, without anticipating results yet to be published, I would say that, quite contrary to my expectation, very sensible correlations exist between the psychical characters and the handwriting, which on the other hand has only very moderate or zero correlations with the physical characters. In school children at any rate, temper, probity and assertiveness are all correlated with the character of the handwriting, and I have little hesitation myself therefore in including it with the psychical rather than the physical group.

These remarks on the individual characters dealt with may enable the reader to understand something of the method adopted in analysing our material. They will at any rate suggest that many points have been considered and investigated which cannot be even touched upon here, but which have aided us in our classifications and general treatment*.

### (iv) *Comparison of the Values found for the Inheritance of the Physical and Psychical Characters in Man.*

Thus far my whole object has been to describe the sources of my material, and to throw some light, perchance, on the new methods we have adopted in classification and computation. I have spent a considerable time over this latter topic, because to the anthropologist of the older school, the biometrician too often appears as a juggler in figures. It is impossible, perhaps, to help this at present, when the biometrician is introducing a new calculus, which cannot be learnt without hard work, and which cannot be handled without training. We are not endeavouring to discredit anthropology, but to furnish such branches of it as anthropometry and craniology with new tools—a little sharp-edged to the uninitiated who handle them incautiously—but which will raise anthropometry and craniology in the future into the category of the more exact sciences. Such must be my excuse for describing so fully, and yet, I fear, so ineffectually, the processes we have adopted. It is another point to ask you to admit that I came to this inquiry without prejudice. I expected *a priori* to find the home environment largely affecting the resemblance in moral qualities of brothers and sisters. I expected to find a spurious emphasis of the inheritance of the moral qualities owing to this environment. Putting any thought of prejudice on one side, accept for a moment the methods adopted, and listen—regardless of the drummers—to the broad results

* For example upwards of 120 correlations between physical characters, between psychical characters and between physical and psychical characters have been worked out, tending to throw light on the interrelationships of these supposed widely differentiated sides of the human character.

of the inquiry. You have in Table I. (see p. 140) the mean of the resemblance in physical characters of brothers and sisters from my records of family measurements. You have in Table III. the mean of the physical measurements of our school records—16 series in the first, 24 series in the latter. I venture to say that

TABLE III.

*Inheritance of the Physical Characters.*

School Observations on Children.

| Character. | Correlation. | | |
|---|---|---|---|
| | Brothers. | Sisters. | Brother and Sister. |
| Health ... ... ... | ·52 | ·51 | ·57 |
| Eye Colour ... ... ... | ·54 | ·52 | ·53 |
| Hair „ ... ... ... | ·62 | ·57 | ·55 |
| Hair Curliness ... ... | ·50 | ·52 | ·52 |
| Cephalic Index ... ... | ·49 | ·54 | ·43 |
| Head Length ... ... ... | ·50 | ·43 | ·46 |
| Head Breadth... ... ... | ·59 | ·62 | ·54 |
| Head Height ... ... ... | ·55 | ·52 | ·49 |
| Mean ... ... ... ... | ·54 | ·53 | ·51 |
| Athletic Power ... ... | ·72 | ·75 | ·49 |

remembering the possible slips in measurement and in classification, there is not the slightest doubt that those two series absolutely confirm each other, and give a mean degree of resemblance of nearly ·5 between children of the same parents for physical characters. How much of that physical resemblance is due to home environment? You might at once assert that size of head and size of body are influenced by nurture, food, and exercise. It is quite true; even curliness may be subject to home influences. But what is the broad effect of such environment on our coefficients of heredity? Can any possible home influence be brought to bear on cephalic index, on hair colour, or eye colour? I fancy not, and yet these characters are within broad lines inherited exactly like the characters directly capable of being influenced by nurture and exercise. I am compelled to conclude that the environmental influence on physical characters, however great in some cases, is not to the first approximation a great disturbing factor when we consider

coefficients of fraternal resemblance in man. I do not believe it to be at all comparable with the irregularities that arise from random sampling and occasional carelessness in measurement or in appreciation of character.

Now turn to Table IV. giving the degree of resemblance in the mental and moral characters. What do we find in it? Perhaps slightly more irregularity in the

TABLE IV.

*Inheritance of the Mental Characteristics.*

School Observations on Children.

| Character. | Correlation. | | |
|---|---|---|---|
| | Brothers. | Sisters. | Brother and Sister. |
| Vivacity ... ... ... | ·47 | ·43 | ·49 |
| Assertiveness ... ... ... | ·53 | ·44 | ·52 |
| Introspection ... ... ... | ·59 | ·47 | ·63 |
| Popularity ... ... ... | ·50 | ·57 | ·49 |
| Conscientiousness ... ... | ·59 | ·64 | ·63 |
| Temper ... ... ... | ·51 | ·49 | ·51 |
| Ability ... ... ... | ·46 | ·47 | ·44 |
| Handwriting ... ... ... | ·53 | ·56 | ·48 |
| Mean ... ... ... ... | ·52 | ·51 | ·52 |

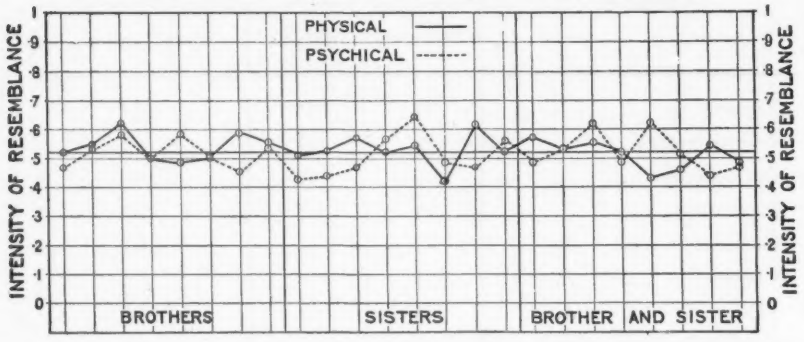
values than in the case of the physical characters. The judgment required is much finer; and the classification is much rougher. Let me frankly admit the difficulties of the task, both for observers and computers. I will lay no weight whatever, if you like, on the second place of decimals. But what is the obvious conclusion? Why, that the values of the coefficient again cluster round ·5. If anything the average degree of resemblance for the psychical is rather less than for the physical, it certainly is not greater. Personally I would lay not a grain's weight on the difference.

I have illustrated the whole result in Diagram XIII. The two lines representing physical and psychical qualities go bobbing up and down, and cutting and re-cutting one another. No wise man, however, would venture to assert that one or other is sensibly uppermost, or that any of those rises or falls have real significance. We are forced absolutely to the conclusion that the degree of

resemblance of the physical and mental characters in children is one and the same.

It has been suggested that this resemblance in the psychical characters is compounded of two factors, inheritance on the one hand and training or environment on the other. If so, you must admit that inheritance and environment make up the resemblance in the physical characters. Now these two sorts of resemblance being of the same intensity, either the environmental influence is the same in both cases, or it is not. If it is the same, we are forced to the conclusion that it is insensible, for it cannot influence eye colour. If it is not the same, then it would be a most marvellous thing, that with varying degrees of inheritance, some mysterious force always modifies the extent of home

DIAGRAM XIII. *Comparison of Resemblance for Physical and Psychical Characters.*




influence, until the resemblance of brothers or sisters is brought sensibly up to the same intensity! Occam's razor will enable us at once to cut off such a theory. We are forced, I think literally forced, to the general conclusion that the physical and psychical characters in man are inherited within broad lines in the same manner, and with the same intensity. The average home environment, the average parental influence is in itself part of the heritage of the stock and not an extraneous and additional factor emphasising the resemblance between children from the same home.

But we are not yet at the end of our conclusions. By assuming our normal distribution for the psychical characters we have found, not only self-consistent results—linear regression, for example, as in the case of the inheritance of intelligence, but we have found the *same* degree of resemblance between physical and psychical characters. That *sameness* surely involves something additional. *It involves a like heritage from parents.* The degree of resemblance between children and parents for the physical characters in man may be applied to the degree of resemblance between children and parents for psychical characters. We inherit our parents' tempers, our parents' conscientiousness, shyness and ability, even as we inherit their stature, forearm and span.

At what rate is that? I show you a table (*see* Table V.), which represents our present knowledge of parental inheritance in man*, and in other species. I venture to say that—within broad lines—the physical characters are inherited at the same rate in man and in the lower forms of life. The resemblance of parent and offspring is again roughly ·5.

TABLE V.

*Parental Inheritance in Different Species.*

| Species | Character | Mean value | No. of pairs used | Source | Remarks |
|---|---|---|---|---|---|
| Man ... ... | Stature | ·506 | 4886 | *Biometrika*, Vol. II. p. 358 | — |
| " ... ... | Span | ·459 | 4873 | ditto | — |
| " ... ... | Forearm | ·418 | 4866 | ditto | — |
| " ... ... | Eye colour | ·495 | 4000 | *Phil. Trans.*, Vol. 195, p. 106 | — |
| Horse ... ... | Coat colour | ·522 | 4350 | *Phil. Trans.*, Vol. 195, p. 93 | — |
| Basset Hound ... | Coat colour | ·524 | 823 | *R. S. Proc.*, Vol. 66, p. 154 | Dams only used |
| Greyhound ... | Coat colour | ·507 | 9279 | Unpublished data for two characters | Dams and sires both used |
| Aphis (*Hyalopterus Trirhodus*) ... | $\frac{\text{Right antenna}}{\text{Frontal breadth}}$ | ·439 | 368 | *Biometrika*, Vol. I. p. 139 | Ratios only taken to free from growth factor |
| Daphnia *Magna* ... | $\frac{\text{Protopodite}}{\text{Body length}}$ | ·466 | 96 | *R. S. Proc.*, Vol. 65, 1899 | |

What conclusion flows upon us irresistibly from the inspection of such a table? Why, that the psychical characters are not features which differentiate man from the lower types of life. If they are inherited like man's physical characters, if they are inherited even as the protopodite of the water flea, what reason is there for demanding a special evolution for man's mental and moral side? We look upon the universe and wonder. The man of science probes a little deeper into nature than the ordinary mortal, but the deeper he probes, the greater his wonder, for the more complex and mysterious the universe appears. Do you wish to draw the line of mystery at living forms? Look at the sky on a clear night, and realise that while astronomers have *described* the motions of a tiny corner of the universe, they have not the least explanation of how and why those motions are taking place.

Nay, take the least, apparently most inert particle of metal, and remember that if modern physical views are correct, millions, probably billions of small corpuscles are in relative motion within it, with a complexity and yet probably with an underlying order as great as in the starry universe, even if they be on a totally different scale. Remember that we have scarcely touched the fringe of a description of those motions, and that their *why* is as inexplicable to us as the motions of the celestial bodies themselves. Note all this, and ask yourselves if there be less mystery

* Taken from a memoir: "On the Laws of Inheritance in Man. I. Inheritance of the Physical Characters." *Biometrika*, Vol. II. p. 379.

in the motions of non-living than of living things. You may call a man who would link up the motion of living to non-living things a materialist. But the materialist in no way lessens the endless mystery of the universe. He knows not what matter is, why it moves, or how he comes to be conscious of its motion. He is but fulfilling the task of science, the linking of mystery to mystery, by bringing them under one common wider conception of the ultimately inexplicable. So it is when we pass from the lower living forms to man. If we see that his physical development is closely allied to brute development, we link mystery to mystery in a common description—a law if you like—but it removes no grain of the ultimate mystery of why life is there, and why it develops. Lastly, turning to the psychical character of man, to some the greatest of all mysteries, we link it up to the physical. We see the man, not only physically, but morally and mentally, the product of a long line of ancestry. We realise that evolution and selection play no greater, and play no less a part in the production of the psychical character than in the production of the physique of man. Once fully realise that the psychic is inherited in the same way as the physical, and there is no room left to differentiate one from the other in the evolution of man. Realise all this, and two mysteries have been linked into one mystery, but the total mystery is no less in magnitude, and no more explicable than it was before. We know not why living forms vary, nor why either physical or psychical characters are inherited, nor wherefore the existence at all of living forms, and their subjection to the great principle of selective evolution. We have learnt only a law common to the physical and the psychical; we have not raised the one or debased the other, because in a world where the ultimate source of change is utterly inexplicable, whether you strive to perceive it through matter like a physicist, through the lower living forms like the biologist, or through man like the anthropologist, all terminology like higher and lower is futile. Where the mystery is absolute in all cases, there can be no question of grade.

But I would not leave you with a mere general declaration that all is mystery, that scientific ignorance of the ultimate is profound. Rather I would emphasise what I have endeavoured to show you to-night, that the mission of science is not to explain but to bring all things, as far as we are able, under a common law. Science gives no real explanation, but provides comprehensive description. In the narrower field it has to study how its general conceptions bear on the comfort and happiness of man. Herein, I think, lies especially the coming function of anthropology. Anthropology has in the first place to study man, to discover the sequence of his evolution from his present comparative stages and from his past history. But it cannot halt here; it must suggest how those laws can be applied to render our own human society both more stable and more efficient. In this function it becomes at least the handmaiden of statecraft, if indeed it were not truer to call it the preceptor of statesmen.

If the conclusion we have reached to-night be substantially a true one, and for my part I cannot for a moment doubt that it is so, then what is its lesson for us as

a community? Why simply that geniality and probity and ability may be fostered indeed by home environment and by provision of good schools and well equipped institutions for research, but that their origin, like health and muscle, is deeper down than these things. They are bred and not created. That good stock breeds good stock is a commonplace of every farmer; that the strong man and woman have healthy children is widely recognized too. But we have left the moral and mental faculties as qualities for which we can provide amply by home environment and sound education.

It is the stock itself which makes its home environment, the education is of small service, unless it be applied to an intelligent race of men.

Our traders declare that we are no match for Germans and Americans. Our men of science run about two continents and proclaim the glory of foreign universities and the crying need for technical instruction. Our politicians catch the general apprehension and rush to heroic remedies. Looking round impassionately from the calm atmosphere of anthropology, I fear there really does exist a lack of leaders of the highest intelligence, in science, in the arts, in trade, even in politics. I do seem to see a want of intelligence in the British merchant, in the British professional man and in the British workman. But I do not think the remedy lies solely in adopting foreign methods of instruction or in the spread of technical education. I believe we have a paucity, just now, of the better intelligences to guide us, and of the moderate intelligences to be successfully guided. The only account we can give of this on the basis of the results we have reached to-night is that we are ceasing as a nation to breed intelligence as we did fifty to a hundred years ago. The mentally better stock in the nation is not reproducing itself at the same rate as it did of old; the less able, and the less energetic, are more fertile than the better stocks. No scheme of wider or more thorough education will bring up in the scale of intelligence hereditary weakness to the level of hereditary strength. The only remedy, if one be possible at all, is to alter the relative fertility of the good and the bad stocks in the community. Let us have a census of the effective size of families among the intellectual classes now and a comparison with the effective size of families in the like classes in the first half of last century. You will, I feel certain, find, as in the case of recent like censuses in America, that the intellectual classes are now scarcely reproducing their own numbers, and are very far from keeping pace with the total growth of the nation. Compare in another such census the fertility of the more intelligent working man with that of the uneducated hand labourer. You will, I again feel certain, find that grave changes have taken place in relative fertility during the last forty years. We stand, I venture to think, at the commencement of an epoch, which will be marked by a great dearth of ability. If the views I have put before you to-night be even approximately correct, the remedy lies beyond the reach of revised educational systems; we have failed to realise that the psychical characters, which are, in the modern struggle of nations, the backbone of a state, are not manufactured by home and school and college; they are bred in the bone;

and for the last forty years the intellectual classes of the nation, enervated by wealth or by love of pleasure, or following an erroneous standard of life, have ceased to give us in due proportion the men we want to carry on the ever-growing work of our empire, to battle in the fore-rank of the ever intensified struggle of nations.

Do not let me close with too gloomy a note. I do not merely state our lack. I have striven by a study of the inheritance of the mental and moral characters in man to see how it arises, and to know the real source of an evil is half-way to finding a remedy. That remedy lies first in getting the intellectual section of our nation to realise that intelligence can be aided and be trained, but no training or education can *create* it. You must breed it, that is the broad result for state-craft which flows from the equality in inheritance of the psychical and the physical characters in man.

### *Addendum, April*, 1904.

I hardly know whether it is needful to refer here to a recent article by Mr C. Spearman in *The American Journal of Psychology* (Vol. xv. pp. 72—101), criticising my results for the similarity of inheritance in the physical and psychical characters. Without waiting to read my paper in full he seems to think that I must have disregarded "home influences" and the personal equation of the school teacher. He proceeded to 'correct' my results for the error of what he calls dilation on the double basis (i) of a formula invented by himself, but given without proof, and (ii) of his own experience that two observers' observations or measurements of the same series of two characters were such that the correlation between their determinations was ·58 in one case and ·22 in the other. The formula invented by Mr Spearman for his so-called 'dilation' is clearly wrong, for applied to perfectly definite cases, it gives values greater than unity for the correlation coefficient. As to his second basis, all I can say is that if the correlation between two observers of the same thing in Mr Spearman's case can be as low as ·22, he must have employed most incompetent observers, or given them most imperfect instructions, or chosen a character suitable for random guessing rather than observation in the scientific sense. Mr Spearman says that "it is difficult to avoid the conclusion that the remarkable coincidence announced between physical and mental heredity can be more than mere accidental coincidence" (p. 98). I think I may safely leave him to calculate the odds for or against this most remarkable "mere accidental coincidence." I may take occasion later to return to Mr Spearman's paper, but at present it may suffice to say that not only are his formulae, especially for probable errors, erroneous, but he quite misunderstands and misuses partial correlation coefficients (p. 95). Further his statements as to the number of cases desirable for an experiment would be extremely dangerous, if they were in the least likely to be generally regarded. In particular one can only pillory such an assertion as that "It was shown in the same part that the size of the probable error also varies according to the method of calculation—and to such an extent that twenty cases treated in one of the ways described [Mr Spearman's own new method] furnish as much certitude as 180 in another more usual way" (p. 100). Perhaps the best thing at present would be for Mr Spearman to write a paper giving algebraical proofs of all the formulae he has used, and if he did not discover their erroneous character in the process, he would at least provide tangible material for definite criticism, which it is difficult to apply to mere unproven assertions.

## APPENDIX Ia.

[*Any Teacher willing to give assistance in these observations—an assistance which will be duly acknowledged in the final publication of results—is requested to communicate with* Professor KARL PEARSON, F.R.S., *University College, London.*]

### GENERAL DIRECTIONS FOR FILLING UP DATA PAPERS OF COLLATERAL HEREDITY*.

1. The object of this investigation is two-fold :

   (i) To ascertain the degree of resemblance, mental and physical, between children of the same parents.

   (ii) To discover, if possible, whether there is any relationship between the external shape of the head and a teacher's estimate of the general grade of ability of the pupil.

Co-operators are warned *ab initio* that no inferences whatever can be drawn from individual instances or from a small series of measurements. The numerical quantities to be determined are small, and it is only when large masses of observations have been collected from many quarters and have been reduced that reliable inferences can be drawn.

2. The measurements and estimates are to be made on :

   (i) Pairs of brothers (white data paper).

   (ii) Pairs of sisters (pink data paper).

   (iii) Pairs of brothers and sisters (blue data paper).

Care must be taken that the right coloured data paper is selected.

The names of the measured are only required in case there should be need for the verification of any entry, and they will be treated as strictly confidential. Initials, in fact, may be used where it seems desirable, if the observer keeps a key to them for the purpose of reference should reference be required.

The observer should have known *well* both members of the pair measured for at least six months, and, if possible, for a much longer period. The classification is purposely made rather wide and indefinite in order that there may be less hesitation in classifying. What is needed is the general impression of a teacher who has carefully observed his or her pupils.

For both physique and ability it is very desirable that the observer should consult, where it is possible, one or more colleagues before filling up the data paper.

To give some confidence in the scales adopted, I may remark that in response to my appeal in the *Journal of Education*, I received details of some 150 boys and girls tested for ability by three observers independently (language, science, and mathematical teachers) and belonging to half-a-dozen different schools. The agreement in classification was complete in more than 80 per cent. of cases, and only differed by as much as two classes in about 5 per cent. of cases†. This degree of accordance is sufficient for the present statistical purposes.

3. I. *Physique.* In making the record, attention should be paid not only to appearance, energy, and athletic qualities, but to irregularity of attendances owing to ill-health, frequency of visits to school-infirmary, etc.

* The quantitative laws of heredity, such as we have reached at present, do not apply to individual cases, but only to the averages of large numbers. It is important to insist on this, because more than one of my helpers on hearing the results of a particular research has seemed disappointed, remarking that the law does not hold for the family X or the brothers Y.

† Even this amount of divergence would probably have disappeared after a consultation with regard to the individuals classified.

II. *Ability.* (*a*) Some account of this scale will be found in the *Journal of Education* for September, 1898, which it might be well for the observer to examine. The following may help to show the significance of the terms:

*Very Dull.* Capable of holding in their minds only the simplest facts, and incapable of perceiving or reasoning about the relationship between facts.

*Slow Dull.* Capable of perceiving relationship between facts in some few fields with long and continuous effort; but not generally, or without much external assistance.

*Slow.* Very slow progress generally, but with time and continual care progress will be made.

*Slow Intelligent.* Slow generally, although possibly more rapid in certain fields. Quite sure of knowledge when once acquired.

*Intelligent.* Ready to grasp and capable of perceiving facts in most fields; capable of good progress without much effort.

*Quick Intelligent.* Very bright and quick both in perception and in acquirement, and this not only of customary, but of novel, facts. Ready to reason rightly about things on purely self-initiative.

*Inaccurate-Erratic.* Capable of perceiving facts, but quick to form erroneous conclusions about them, illogical and erratic in reasoning.

(*b*) *Handwriting.* If possible, in addition to this classification, get the pair under investigation to write the last lines of Lord Macaulay's *Lay of Horatius*, with their own signatures on the back of the data paper.

(*c*) *Work.* If the individual be good at several subjects, put a cross against all these in the first row; as well as the strongest subject in the next row; if the individual be good at none, make no entry in the first row, but only in the second row, where *best at* must be interpreted in this case as *least bad at*. The individual should be asked his favourite subject and favourite game. Mathematics covers Arithmetic and Geometry: Descriptive Science includes Botany, Experimental Physics, Physiography, etc.

III. *Head Measurements.* These are to be made with the head-spanner, full directions for the use of which are given in its case.

IV. *Hair.* Comment seems unnecessary.

V. *Eyes.* Light covers blue of all shades, light grey, very light green; medium covers dark grey, green, light chestnut, orange and grey combined; dark covers dark chestnut, light and dark brown, black.

VI. *Relative Characters.* This entry is needful for the numerical reduction of the statistics in those cases in which both brothers have been given the *same* class, otherwise no use should be made of it.

If the characteristic be equally strong in both, write equal, instead of putting a cross.

VII. If the alternative characteristics are neither possessed in a marked degree, place the cross on the dividing line.

VIII. *General Remarks.* Under this heading it may be useful *occasionally* to note any marked physical or mental characteristic of the pair. Care should, however, be taken not to lay greater stress on points of resemblance than on points of diversity.

4. It is most desirable that the head-spanners should not be kept longer than four to six weeks, in order that they may be sent on as rapidly as possible to other schools. They should be returned with the stamped and addressed labels. Any school anthropometrical laboratory desiring to procure a head-spanner of the present pattern, can do so at a cost of 19*s.* 6*d.*, from the Cambridge Scientific Instrument Company, Carlyle Road, Cambridge.

The spanners need to be carefully handled. Should any part be broken or lost the box with the spanner should be returned at once, in order that it may be repaired without delay and again sent out for use.

Any special inquiries should be addressed to me, at University College, London.

KARL PEARSON.

## APPENDIX Ib.

## DATA PAPER FOR COLLATERAL HEREDITY INVESTIGATIONS.

### B. SISTER-SISTER SERIES.

(Whole, not half sisters.)

No. in whole series. (Not to be filled in.)

*Please return this Paper to Professor KARL PEARSON, F.R.S., University College, London.*

School :

Observer :

No. in School Series

Date :

Place a cross against the class of each sister under as many headings as possible, except under III and VIII. Please read first the General Directions.

| | Elder Sister. | Younger Sister. |
|---|---|---|
| Name ... ... ... ... ... | | |
| Age ... ... ... ... ... | | |
| District of Home ... ... ... | | |

**I. PHYSIQUE :**

| | Very Strong. | Strong. | Normally Healthy. | Rather Delicate. | Very Delicate. | Athletic. | Non-Athletic. |
|---|---|---|---|---|---|---|---|
| Elder Sister ... | | | | | | | |
| Younger Sister .. | | | | | | | |

**II. ABILITY :** (*a*) *General Scale.*

| | Quick Intelligent. | Intelligent. | Slow Intelligent. | Slow. | Slow Dull. | Very Dull. | Inaccurate-Erratic. |
|---|---|---|---|---|---|---|---|
| Elder Sister ... | | | | | | | |
| Younger Sister ... | | | | | | | |

(*b*) **HANDWRITING :** (*See Back.*)

| | Very Good. | Good. | Moderate. | Poor. | Bad. | Very Bad. |
|---|---|---|---|---|---|---|
| Elder Sister ... | | | | | | |
| Younger Sister ... | | | | | | |

(*c*) **WORK :**

| | | Classics. | Modern Languages. | History. | Mathematics. | Descriptive Science. | Drawing. | Singing, Music. |
|---|---|---|---|---|---|---|---|---|
| Elder Sister ... | Good at ... | | | | | | | |
| | Best at ... | | | | | | | |
| | Likes best | | | | | | | |
| Younger Sister | Good at ... | | | | | | | |
| | Best at ... | | | | | | | |
| | Likes best | | | | | | | |

(*d*) **GAMES OR PASTIMES :**

| | Elder Sister. | Younger Sister. |
|---|---|---|
| Likes ... | | |
| Good at ... | | |

**III. HEAD MEASUREMENTS :**

| | Length. | Breadth. | Height. | *a*. | *b*. | *c*. |
|---|---|---|---|---|---|---|
| Elder Sister ... | | | | | | |
| Younger Sister ... | | | | | | |

(*a*), (*b*), (*c*), Indices (not to be filled in).

**IV. HAIR :**

| | Red. | Fair. | Brown. | Dark. | Jet Black. | Smooth. | Wavy. | Curly. |
|---|---|---|---|---|---|---|---|---|
| Elder Sister ... | | | | | | | | |
| Younger Sister ... | | | | | | | | |

**V. EYES :**

| | Light. | Medium. | Dark. |
|---|---|---|---|
| Elder Sister ... | | | |
| Younger Sister ... | | | |

**VI. RELATIVE CAPABILITIES :** This is *only* to be filled in in those cases wherein the two sisters fall into the *same* class.

| | Physique, stronger in | More Athletic. | Ability, greater in | Handwriting, better in | Hair, darker in | Eyes, darker in |
|---|---|---|---|---|---|---|
| Elder Sister ... | | | | | | |
| Younger Sister ... | | | | | | |

**VII. CHARACTER, ETC. :**

| | Noisy. | Quiet. | Self-conscious. | Unself-conscious. | Self-assertive. | Shy. | Conscientiousness. Keen. | Conscientiousness. Dull. | Popular. | Unpopular. | Temper. Quick. | Temper. Good-natured. | Temper. Sullen. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elder Sister ... | | | | | | | | | | | | | |
| Younger Sister ... | | | | | | | | | | | | | |

**VIII. GENERAL REMARKS.** Add here any striking features of resemblance or dissimilarity in the sisters.

Elder Sister ...

Younger Sister ...

[On the back of the Schedule spaces were arranged for samples of the handwriting.]

## Appendix II.

*Observers and Schools contributing to the Data upon which this Memoir is based.*

*Aberdeen*, A. N. Meldrum; Ferry Hill Public School, J. D. Anderson. *Aberuthven* School, J. M. S. Math. *Acocks Green*, Wellesbourne House School, O. Sunderland. *Aldenham* School, F. B. Stead. *Alresford*, Swanaton School, W. L. W. Eyre. *Barnard Castle*, County School, F. Hodson. *Bakewell*, Lady Manners' School, H. Martin. *Berwick*, Berwickshire High School, H. S. Mabbatt. *Birmingham*, King Edward's School, F. M. McCarthy; King Edward's School, C. J. Wood; King Edward's School for Girls, M. J. Nimmo and A. L. Parmenter. *Bradford-on-Avon*, Winsley and Turley National School, Alice E. Griffiths. *Bridgend*, County School, W. A. Whittan. *Bridgewater*, St John's School, E. M. Lucas. *Brighton*, Brighton and Hove High School for Girls, R. Mayhew. *Bristol*, Two-Mile Hill Board School, A. F. Bateman. *Buckhurst Hill*, Oakfield School, E. Linder. *Burghead* Public School, M. Brenner. *Burnley*, Higher Grade and Science School, F. H. Hibber. *Cardenden*, Craigderran School, David Rorie. *Cardiff*, Eleanor Street Boys' School, A. C. Badcoe; Intermediate School for Boys, A. Abbatt. *Carlisle*, High School for Girls, A. Beavor and G. Whiting. *Caterham*, Congregational School, F. W. G. Foat. *Cheltenham*, Ladies' College, Catherine E. Berridge. *Chesterfield*, Hipper Street School, S. Steel. *Clacton-on-Sea*, Clacton College, H. Picton. *Clapham*, High School for Girls, M. Cave and Mrs Woodhouse. *Congleton*, St James' School, W. F. Warburton. *Cork*, High School for Girls, H. A. Martin. *Darlington*, Bowes School, D. L. Smith. *Dereham*, Swanton Morley National School, J. Lewton Brain. *Dewsbury* Grammar School, G. Rowland. *Dulwich*, Alleyn's School, J. V. H. Coates; Dulwich College, H. Brereton Baker; Dulwich Village Evening Continuation School, C. T. Hunt. *Dollar* Public School, J. Begg. *Dundee*, Monikie School, P. Grant. *Durham* School, J. T. Johnson. *Duffus* Public School, J. W. Garrigall. *Epsom*, The College, S. R. Browne. *Ferry Hill*, Bishopton School, T. G. Frankton. *Edinburgh*, Fettes College, C. J. N. Fleming and W. I. Sargent. *Fochaber*, Speymouth Public School, A. Geddie. *Folkestone*, Sidney Street Board School, J. A. Hugill. *Glossop*, Arundel School, R. H. Dickinson. *Grangemouth*, Grange Higher Grade Science School, F. W. Maryon. *Grantham*, North Rauceby Church School, A. W. M. Drew and W. H. Baily. *Great Ayton*, Friends' School, F. R. Arundel. *Guernsey*, Island of (numerous schools), E. W. Adair and S. Butler. *Halifax* Higher Board School, W. Dycke. *Harrogate*, Western Board School, J. W. Hammond. *Haslemere*, Fernhurst Board School, H. Watts. *Hassocks*, Clayton School, L. H. Beecher-Shand. *Handsworth*, Grammar School, S. R. Hart. *Haywards Heath*, National Schools, A. J. Mouncher. *Hinckley*, Elementary School, O. C. Hirst. *Hornsey*, Board School, J. C. Hudson. *Huntley*, Corse Public School, A. C. Rathway. *Ilkeley*, Grammar School, F. T. Cramphorn. *Isle of Wight*, Chorley School, G. E. Jeans. *Keighley*, Kiedwich School, T. Appleby. *Keswick*, Keswick School, S. Horton Barnard. *Landewednack*, Board School, J. Carwardine. *Leek*, High School, T. L. Warrington. *Leighton Buzzard*, Linslade School, G. F. Andrill. *Lerwick*, Widows' Asylum, J. Allen. *Leyton*, Elementary School, F. J. Chittenden; Technical Institute, H. Hills. *Lisburn*, Ulster Provincial School, W. D. Braithwaite. *Llandebie* School, T. Mathews. *Liverpool*, High School for Girls, E. Canning; Liverpool Institute, W. S. Saul. *Londonderry*, Fahan School, W. A. Dickson. *Lyme Regis*, National School, J. Radford. *London*, University College School, J. L. Paton and Staff; Whitechapel Road Foundation School, F. Dixon; Priory Grove Board School, W. R. Suddeley; Fernhead Road School, J. C. Bedwell; Goswell Road, St Thomas', Charterhouse, W. W. Woodward; New Southgate, High School, J. Fairquire; Chelsea, Cook's Ground Board School, D. H. Hodge; Walworth, Michael Faraday School, T. M. Upfield; Titchborne Street, St John's

Girls' School, A. McGillvray; Radnor Street Wesleyan School, J. W. Parkinson; Fernham Street Girls' Board School, S. Carter; Dulwich, High School for Girls, M. Barwell; Highbury, High School for Girls, M. Minasi; Notting Hill, High School for Girls, T. F. Grünbaum; Camden Town, North London Collegiate School for Girls, S. Bryant; Limehouse, St Anne's Schools, C. J. Carter; Hampstead, Soldiers' Daughters' Home, C. D. Fawcett; Morley College, J. Denton; Notting Hill School, M. M. Adamson; Limehouse, Higher Grade Board Schools, Thomas Street, J. Crabtree; Old Charton Girls' School, A. Baker; Hampstead, King Alfred's School, J. Russell; Christ's Hospital, C. E. Browne. *Manchester*, Hulme Grammar School, C. H. Crombie; High School for Girls, C. Coignou; Withington, Lady Barn House School, C. Herford. *Mansfield*, Brunt's Technical School, C. E. Stacey. *Margate*, New Cross Street Board School, E. Parker. *Markinch*, Star Public School, Wm. McLachlan. *Marston Green*, Cottage Homes, W. J. Rees. *Merthyr Tydfil* School, M. J. Swift. *Milford Haven* County School, L. Jones. *Morpeth*, Netherwitton Board School, J. Anderson. *Newark*, Beacon Hill School, W. A. Greames. *Newbury* School, C. Cecil Fry; Donnington School, Mrs Bell. *Newcastle-on-Tyne*, Central High School for Girls and other schools, E. W. N. Williams. *Newton Stewart*, Ewart High School, C. S. Dougall. *Norwich*, Angel Road Board School, B. H. Barber. *Nottingham*, Berridge Road Girls' Board School, A. N. Stone; Morley House, B. Smith; Waverley School, H. T. Facon. *Oxford*, High School for Girls, E. Macdonald; Abbey Road School, Miss Sheppard. *Pembroke Dock*, County School, G. W. West. *Pemberton*, St John's Schools, J. T. Milward. *Peterborough*, Fitzwilliam School, G. E. Holmes. *Peterhead* Academy, J. Don. *Petersfield*, Bedales School, T. J. Garstang. *Pinner*, Woodridings School, Z. Haes. *Polperro* School, F. H. Perry-Coste. *Pontefract*, Ackworth School, G. E. Bell. *Pontypridd*, Wesleyan School, W. H. Rees. Mill Street Higher School, J. Farr. *Portsmouth*, High School for Girls, M. M. Adamson. *Pwlheli*, County School, J. W. Evans. *Reigate*, Church High School, E. E. Ardington. *Richmond* (Surrey), County School, A. E. Buckhurst; Richmond Hill School, H. D. Greig. *Royston*, Littlington School, W. C. Whitehead. *Saffron Walden*, Friends' School, E. W. Sawdon. *St Leonards-on-Sea*, Silverhill Girls' School, E. H. Woodd. *Sheffield*, Westbourne School, Miss Sims. *Shrewsbury*, Criggian School, R. Brack; Murivane High School for Girls, G. M. Wise. *South Shields* School, R. Sanderson. *Southwold*, St Felix School, C. M. Sant. *Spennymore* School, H. Askew. *Spilsby*, Spendleby School, A. Teare. *Stranraer*, Ardwell School, D. Thomson. *Swansea* Grammar School, E. H. Tripp. *Sydenham* School, R. Lulham. *Taunton*, King's College, E. B. Vincent. *Tavistock*, Kelly College, P. L. Andrews. *Tottenham* High School, L. F. Ushendoor. *Upholland* Grammar School, D. L. Rennard. *Warrington*, Penketh School, W. E. Brown. *Wellington* College, G. E. Blundell and H. P. Fitzgerald. *West Ham*, Castor House Board School, R. Symes. *Whitehaven*, Girls' School, W. Blackmore. *Winchester* College, W. B. Croft. *Wimbledon*, High School for Girls, Miss Knight. *Windlesham* Board School, J. Simms. *Winscombe*, Sicot School, B. Lean. *Woodford*, Wanstead College, J. B. Martin. *Wragby* School, T. Dixon-Spain. *York*, High School for Girls, M. Leader. *Yeovil*, Kington School, E. H. Davison. *Yiewsley*, St Matthew's Schools, J. J. Wade. *Ystalyfera*, County School, A. B. Gully; and other schools.

## Appendix III.—Detailed Tables.

### I. Physical Characters.

#### Health.

A (i). *Brother-Brother.*

First Brother.

| Second Brother. | Very strong. | Strong. | Normally healthy. | Rather delicate. | Very delicate. | Totals. |
|---|---|---|---|---|---|---|
| Very strong .... | 24 | 31 | 11·5 | 4 | — | 70·5 |
| Strong .... .... | 31 | 342 | 163·75 | 65·75 | 3 | 605·5 |
| Normally healthy .... | 11·5 | 163·75 | 588·5 | 137·25 | 6 | 907 |
| Rather delicate .... | 4 | 65·75 | 137·25 | 95 | 11 | 313 |
| Very delicate .... | — | 3 | 6 | 11 | 2 | 22 |
| Totals .... .... | 70·5 | 605·5 | 907 | 313 | 22 | 1918 |

A (ii). *Sister-Sister.*

First Sister.

| Second Sister | Very strong. | Strong. | Normally healthy. | Rather delicate. | Very delicate. | Totals. |
|---|---|---|---|---|---|---|
| Very strong.... .... | 44·5 | 38·5 | 17·5 | 8·5 | — | 109 |
| Strong .... .... | 38·5 | 306·5 | 154·5 | 74 | 5 | 578·5 |
| Normally healthy .... | 17·5 | 154·5 | 411 | 201·5 | 19 | 803·5 |
| Rather delicate .... | 8·5 | 74 | 201·5 | 166 | 28·5 | 478·5 |
| Very delicate .... | — | 5 | 19 | 28·5 | 15 | 67·5 |
| Totals .... .... | 109 | 578·5 | 803·5 | 478·5 | 67·5 | 2037 |

A (iii). *Brother-Sister.*

Brother.

| Sister. | Very strong. | Strong. | Normally healthy. | Rather delicate. | Very delicate. | Totals. |
|---|---|---|---|---|---|---|
| Very strong .... | 46 | 15 | 7 | 4 | — | 72 |
| Strong .... .... | 35 | 174·5 | 64 | 22·5 | 1 | 297 |
| Normally healthy .... | 17 | 85·25 | 191·75 | 50·5 | 3 | 347·5 |
| Rather delicate .... | 9 | 34·25 | 69·75 | 48 | 3 | 164 |
| Very delicate .... | 1 | 2 | 1 | 2·5 | 6 | 12·5 |
| Totals .... .... | 108 | 311 | 333·5 | 127·5 | 13 | 893 |

EYE COLOUR.

B (i). *Brother-Brother.*

First Brother.

| Second Brother. | Light. | Medium. | Dark. | Totals. |
|---|---|---|---|---|
| Light .... .... .... | 558 | 190 | 81·5 | 829·5 |
| Medium .... .... .... | 190 | 426·5 | 122 | 738·5 |
| Dark .... .... .... | 81·5 | 122 | 228·5 | 432 |
| Totals.... .... .... | 829·5 | 738·5 | 432 | 2000 |

B (ii). *Sister-Sister.*

First Sister.

| Second Sister. | Light. | Medium. | Dark. | Totals. |
|---|---|---|---|---|
| Light .... .... .... | 438·5 | 196·5 | 71·5 | 706·5 |
| Medium .... .... .... | 196·5 | 598 | 136 | 930·5 |
| Dark .... .... .... | 71·5 | 136 | 257·5 | 465 |
| Totals.... .... .... | 706·5 | 930·5 | 465 | 2102 |

B (iii.) *Brother-Sister.*

Brother.

| Sister. | Light. | Medium. | Dark. | Totals. |
|---|---|---|---|---|
| Light .... .... .... | 206·5 | 66·5 | 33 | 306 |
| Medium .... .... .... | 86 | 208·25 | 46·25 | 340·5 |
| Dark .... .... .... | 28 | 53·25 | 104·25 | 185·5 |
| Totals.... .... .... | 320·5 | 328 | 183·5 | 832 |

HAIR COLOUR.

C (i). *Brother-Brother.*

First Brother.

| Second Brother. | Red. | Fair. | Brown. | Dark. | Jet black. | Totals. |
|---|---|---|---|---|---|---|
| Red .... .... .... | 30·5 | 23 | 16 | 12 | — | 81·5 |
| Fair .... .... .... | 23 | 416 | 158 | 67·75 | ·25 | 665 |
| Brown .... .... | 16 | 158 | 394 | 98·25 | 8·25 | 674·5 |
| Dark.... .... .... | 12 | 67·75 | 98·25 | 328·5 | 19 | 525·5 |
| Jet black .... .... | — | ·25 | 8·25 | 19 | 10 | 37·5 |
| Totals .... .... | 81·5 | 665 | 674·5 | 525·5 | 37·5 | 1984 |

C (ii). *Sister-Sister.*

First Sister.

| Second Sister. | Red. | Fair. | Brown. | Dark. | Jet black. | Totals. |
|---|---|---|---|---|---|---|
| Red .... .... .... | 31 | 22 | 19 | 14 | 1 | 87 |
| Fair .... .... .... | 22 | 474 | 195·5 | 47·5 | — | 739 |
| Brown .... .... | 19 | 195·5 | 474 | 162·5 | 4·5 | 855·5 |
| Dark.... .... .... | 14 | 47·5 | 162·5 | 206 | 6·5 | 436·5 |
| Jet black .... .... | 1 | — | 4·5 | 6·5 | 4 | 16 |
| Totals .... .... | 87 | 739 | 855·5 | 436·5 | 16 | 2134 |

C (iii). *Brother-Sister.*

Brother.

| Sister. | Red. | Fair. | Brown. | Dark. | Jet black. | Totals. |
|---|---|---|---|---|---|---|
| Red .... .... .... | 12 | 9·5 | 12·5 | 5 | — | 39 |
| Fair .... .... .... | 10·5 | 198·5 | 73 | 29·5 | — | 311·5 |
| Brown .... .... | 4 | 72 | 138·5 | 57 | 3 | 274·5 |
| Dark.... .... .... | 5 | 32·5 | 52·5 | 91 | 10 | 191 |
| Jet black .... .... | — | 1 | 3 | 4 | 5 | 13 |
| Totals .... .... | 31·5 | 313·5 | 279·5 | 186·5 | 18 | 829 |

CURLINESS OF HAIR.

D (i). *Brother-Brother.*

First Brother.

| Second Brother. | Smooth. | Wavy. | Curly. | Totals. |
|---|---|---|---|---|
| Smooth .... .... .... | 1556·5 | 111·5 | 34·5 | 1702·5 |
| Wavy .... .... .... | 111·5 | 134·5 | 20 | 266 |
| Curly .... .... .... | 34·5 | 20 | 11 | 65·5 |
| Totals.... .... .... | 1702·5 | 266 | 65·5 | 2034 |

D (ii). *Sister-Sister.*

First Sister.

| Second Sister. | Smooth. | Wavy. | Curly. | Totals. |
|---|---|---|---|---|
| Smooth .... .... .... | 937·5 | 190·5 | 98 | 1226 |
| Wavy .... .... .... | 190·5 | 213·5 | 52 | 456 |
| Curly .... .... .... | 98 | 52 | 76 | 226 |
| Totals.... .... .... | 1,226 | 456 | 226 | 1908 |

D (iii). *Brother-Sister.*

Brother.

| Sister. | Smooth. | Wavy. | Curly. | Totals. |
|---|---|---|---|---|
| Smooth .... .... .... | 395·5 | 24 | 12 | 431·5 |
| Wavy .... .... .... | 106·5 | 33 | 11 | 150·5 |
| Curly .... .... .... | 49 | 11 | 17 | 77 |
| Totals.... .... ... | 551 | 68 | 40 | 659 |

E (i).

*Cephalic Index. Brother-Brother.*

First Brother.

| | 67—68 | 68—69 | 69—70 | 70—71 | 71—72 | 72—73 | 73—74 | 74—75 | 75—76 | 76—77 | 77—78 | 78—79 | 79—80 | 80—81 | 81—82 | 82—83 | 83—84 | 84—85 | 85—86 | 86—87 | 87—88 | 88—89 | 89—90 | 90—91 | 91—92 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 67—68 | — | 1 | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 |
| 68—69 | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| 69—70 | — | — | — | — | 2 | — | — | — | 1 | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | 8 |
| 70—71 | 1 | 1 | — | — | 2 | 2 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 8 |
| 71—72 | — | — | 1 | 2 | — | 2 | 2 | 2 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 26 |
| 72—73 | 1 | — | — | 2 | 2 | — | 2 | 1 | 5 | 2 | 4 | 2 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 23 |
| 73—74 | — | — | — | 1 | 2 | 3 | — | 2 | 3 | 2 | 2 | 1 | 2 | — | — | — | 1 | — | — | — | — | — | — | — | — | 49 |
| 74—75 | — | — | — | 2 | 1 | 5 | 2 | — | 2 | 1 | 1 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 78 |
| 75—76 | — | — | 2 | 1 | 5 | 7 | 1 | 2 | — | 1 | 1 | — | — | 1 | 1 | — | — | — | 1 | — | — | — | — | — | — | 156·5 |
| 76—77 | — | — | — | — | 2 | 10 | 2 | 3 | 2 | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 181·5 |
| 77—78 | — | — | — | — | 2 | 8 | — | 1 | 2 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 236·5 |
| 78—79 | — | — | — | — | 4 | 11 | — | 2 | 4 | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 293·5 |
| 79—80 | — | — | — | — | 2 | 13 | — | 1 | 2 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 227·5 |
| 80—81 | — | — | — | — | 1 | 3 | — | 3 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 181·5 |
| 81—82 | — | — | — | — | — | 7 | — | 2 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 156 |
| 82—83 | — | — | — | — | — | 2 | — | 1 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 130 |
| 83—84 | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 93 |
| 84—85 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 58 |
| 85—86 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 31 |
| 86—87 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 23 |
| 87—88 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 7 |
| 88—89 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 4 |
| 89—90 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 4 |
| 90—91 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| 91—92 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Totals | 3 | 2 | 8 | 8 | 26 | 23 | 49 | 78 | 156·5 | 181·5 | 236·5 | 293·5 | 227·5 | 181·5 | 156 | 130 | 93 | 58 | 31 | 23 | 7 | 4 | 4 | 1 | 1 | 1962 |

Second Brother.

E (ii).

*Cephalic Index. Sister-Sister.*

First Sister.

| Second Sister. | 62·5—63·5 | 63·5—64·5 | 64·5—65·5 | 65·5—66·5 | 66·5—67·5 | 67·5—68·5 | 68·5—69·5 | 69·5—70·5 | 70·5—71·5 | 71·5—72·5 | 72·5—73·5 | 73·5—74·5 | 74·5—75·5 | 75·5—76·5 | 76·5—77·5 | 77·5—78·5 | 78·5—79·5 | 79·5—80·5 | 80·5—81·5 | 81·5—82·5 | 82·5—83·5 | 83·5—84·5 | 84·5—85·5 | 85·5—86·5 | 86·5—87·5 | 87·5—88·5 | 88·5—89·5 | 89·5—90·5 | 90·5—91·5 | 91·5—92·5 | Totals ... |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62·5—63·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 63·5—64·5 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 64·5—65·5 | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 65·5—66·5 | | 1·5 | 1·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 66·5—67·5 | 1 | 1·5 | 1·5 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 67·5—68·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 68·5—69·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 69·5—70·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 70·5—71·5 | | ·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 71·5—72·5 | | 1·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 72·5—73·5 | | 1·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 73·5—74·5 | | 1·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 74·5—75·5 | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 75·5—76·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 76·5—77·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 77·5—78·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 78·5—79·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 79·5—80·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 80·5—81·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 81·5—82·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 82·5—83·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 83·5—84·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 84·5—85·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 85·5—86·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 86·5—87·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 87·5—88·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 88·5—89·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 89·5—90·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 90·5—91·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 91·5—92·5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Totals ... | 7 | 8 | 4 | 6 | 9 | 5 | 12 | 28·5 | 21 | 50 | 59·5 | 68·5 | 96·5 | 161·5 | 190·5 | 226 | 231 | 205 | 166 | 159 | 87 | 52 | 41·5 | 22 | 6·5 | 5 | 2 | 1 | 3·5 | 1936 |

E (iii).

*Cephalic Index. Brother-Sister.*

Brother.

| Sister. | 70—71 | 71—72 | 72—73 | 73—74 | 74—75 | 75—76 | 76—77 | 77—78 | 78—79 | 79—80 | 80—81 | 81—82 | 82—83 | 83—84 | 84—85 | 85—86 | 86—87 | 87—88 | 88—89 | 89—90 | Totals ... | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *68—69* | — | — | — | 1 | — | — | ·5 | ·5 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | 5 | 1 |
| *69—70* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 7 | 2 |
| *70—71* | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 11 | 3·5 |
| *71—72* | — | — | 1 | — | 1·5 | 2·5 | — | — | 1·5 | — | — | — | — | — | — | — | — | — | — | — | 31 | 11·5 |
| *72—73* | — | 1 | — | 2 | ·5 | ·5 | 4·5 | 1·5 | — | — | — | — | — | — | — | — | — | — | — | — | 30·5 | 13 |
| *73—74* | 1 | — | 1 | 4·5 | 4·5 | 2·5 | 2·5 | 3·5 | — | 1 | — | 1·5 | 1·5 | — | — | — | — | — | — | — | 61 | 14 |
| *74—75* | — | 1·5 | ·5 | 4·5 | 4·5 | 2·5 | 2·5 | 3·5 | 1 | 1·5 | 1·5 | 1 | 1·5 | 2 | 1·5 | — | — | — | — | — | 73 | 36 |
| *75—76* | — | 2·5 | ·5 | 2·5 | 2·5 | 4·5 | 2·5 | 3·5 | 1 | 1·5 | 1·5 | 1 | 1·5 | 1 | 1·5 | — | — | — | — | — | 83 | 51 |
| *76—77* | ·5 | — | 1·5 | 2 | 3·5 | 2·5 | 3 | 5 | 4 | 5 | 2 | 3 | 2 | 1 | 2 | — | — | — | — | — | 105·5 | 70 |
| *77—78* | ·5 | 1 | 1·5 | — | — | — | 5 | 13·5 | 7·5 | 5 | 2 | 2 | 2·5 | 1·5 | 1· | — | — | — | — | — | 81 | 74·5 |
| *78—79* | 1 | 1 | — | — | 1 | 1 | 4 | 7·75 | 10·5 | 5·5 | 2·5 | 3·5 | 3·5 | 3·5 | ·5 | 1 | 1 | — | — | — | 76·5 | 106·5 |
| *79—80* | 1 | — | — | 1·5 | ·5 | 1 | 7 | 11·25 | 5·5 | 5·5 | 2·5 | 3·5 | 3·5 | 4·5 | 1 | — | 1 | — | — | — | 61·5 | 84 |
| *80—81* | — | — | — | — | — | — | 7 | 5·5 | 2·5 | 2·5 | 3·5 | 3·5 | 3·5 | 4·5 | 1·5 | — | — | — | — | — | 37·5 | 81·5 |
| *81—82* | — | — | — | — | — | — | 11·25 | 6·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 4·5 | 1·5 | — | — | — | — | — | 27·5 | 54 |
| *82—83* | — | — | — | — | — | — | 7·75 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 4·5 | 1·5 | — | — | — | — | — | 18·5 | 42 |
| *83—84* | — | — | — | — | — | — | 10·5 | 5·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 4·5 | 1·5 | — | — | — | — | — | 8·5 | 36 |
| *84—85* | — | — | — | — | — | — | 5·5 | 2·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 4·5 | 1·5 | — | — | — | — | — | 5 | 22 |
| *85—86* | — | — | — | — | — | — | 2·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 4·5 | 1·5 | — | — | — | — | — | 4 | 11 |
| *86—87* | — | — | — | — | — | — | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 4·5 | 1·5 | — | — | — | — | — | 4 | 9·5 |
| *87—88* | — | — | — | — | — | — | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 4·5 | 1·5 | — | — | — | — | — | 3 | 3 |
| *88—89* | — | — | — | — | — | — | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 4·5 | 1·5 | — | — | — | — | — | 3 | 2 |
| *89—90* | — | — | — | — | — | — | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 3·5 | 4·5 | 1·5 | — | — | — | — | — | 3 | 4 |
| Totals ... | 5 | 7 | 11 | 31 | 30·5 | 61 | 73 | 83 | 105·5 | 81 | 76·5 | 61·5 | 37·5 | 27·5 | 18·5 | 8·5 | 5 | 4 | 3 | 1 | 1 | 732 |

F (i).

*Head Length reduced to* 12 *years. Brother-Brother.*

First Brother.

| Second Brother. | *163·5* | *165·5* | *167·5* | *169·5* | *171·5* | *173·5* | *175·5* | *177·9* | *179·5* | *181·5* | *183·5* | *185·5* | *187·5* | *189·5* | *191·5* | *193·5* | *195·5* | *197·5* | *199·5* | *201·5* | *203·5* | *205·5* | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *163·5* | — | — | — | 1 | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| *165·5* | — | — | ·5 | — | — | — | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 2·5 |
| *167·5* | — | ·5 | 1 | 1 | — | — | ·5 | ·5 | — | — | — | ·5 | — | — | — | — | — | — | — | — | — | — | 4 |
| *169·5* | 1 | — | 1 | 2 | 1·5 | 4 | 3 | 4 | 1 | 1 | 2 | 1·5 | 2 | — | — | — | — | — | — | — | — | — | 24 |
| *171·5* | — | — | — | 1·5 | 4 | 5·5 | 4·5 | 9·5 | 2 | 5 | 2 | 3 | 3 | 1 | 1 | — | 1 | 1 | — | — | — | — | 44 |
| *173·5* | — | — | — | 4 | 5·5 | 2 | 5·5 | 15·5 | 2·5 | 6 | 6·5 | 3 | 1·5 | — | — | — | 1·5 | — | — | — | — | — | 53·5 |
| *175·5* | — | — | ·5 | 3 | 4·5 | 5·5 | 7 | 5 | 12 | 18·5 | 16·5 | 7·5 | 4·25 | 3·75 | 1 | — | ·5 | 1 | — | — | — | — | 90·5 |
| *177·5* | 1 | 1 | ·5 | 4 | 9·5 | 15·5 | 5 | 17 | 24 | 21 | 20·5 | 10·75 | 8 | 4·25 | 4·5 | 2·5 | — | 1 | — | — | — | — | 150 |
| *179·5* | — | 1 | — | 1 | 2 | 2·5 | 12 | 24 | 32 | 25 | 29 | 28·5 | 15 | 4·5 | 5·5 | 1 | 2 | — | — | — | — | 1 | 186 |
| *181·5* | — | — | — | 1 | 5 | 6 | 18·5 | 21 | 25 | 24 | 42·5 | 24·75 | 24·75 | 12·25 | 17·75 | 4·5 | 2 | 1 | — | — | — | — | 230 |
| *183·5* | — | — | — | 2 | 2 | 6·5 | 16·5 | 20·5 | 29 | 42·5 | 53·5 | 35 | 35·5 | 19·75 | 16·75 | 5·5 | 4·5 | 2·5 | 2·5 | 1 | — | — | 295·5 |
| *185·5* | — | — | ·5 | 1·5 | 3 | 3 | 7·5 | 10·75 | 28·5 | 24·75 | 35 | 28·5 | 31 | 23·25 | 24 | 7·25 | 4·5 | 2 | 1·5 | 1 | — | — | 238·5 |
| *187·5* | — | — | — | 2 | 3 | 1·5 | 4·25 | 8 | 15 | 24·75 | 35·5 | 31 | 28 | 23·75 | 17·75 | 13 | 6·5 | 2 | ·5 | — | — | 1 | 217·5 |
| *189·5* | — | — | — | — | 1 | — | 3·75 | 4·25 | 4·5 | 12·25 | 19·75 | 23·25 | 23·75 | 33 | 26·75 | 15·5 | 9·75 | 7 | 4 | 1 | — | — | 189·5 |
| *191·5* | — | — | — | — | 1 | — | 1 | 4·5 | 5·5 | 17·75 | 16·75 | 24 | 17·75 | 26·75 | 23 | 9·75 | 10·75 | 4 | 2 | ·5 | 1 | — | 166 |
| *193·5* | — | — | — | — | — | — | — | 2·5 | 1 | 4·5 | 5·5 | 7·25 | 13 | 15·5 | 9·75 | 16 | 4·5 | 6 | 3·5 | — | — | — | 89 |
| *195·5* | — | — | — | — | 1 | 1·5 | ·5 | — | 2 | 2 | 4·5 | 4·5 | 6·5 | 9·75 | 10·75 | 4·5 | 5 | 5·5 | 2·5 | 1 | — | — | 61·5 |
| *197·5* | — | — | — | — | 1 | — | 1 | 1 | — | 1 | 2·5 | 2 | 2 | 7 | 4 | 6 | 5·5 | 3 | ·5 | 1·5 | — | — | 38 |
| *199·5* | — | — | — | — | — | — | — | — | — | — | 2·5 | 1·5 | ·5 | 4 | 2 | 3·5 | 2·5 | ·5 | — | 1·5 | — | — | 18·5 |
| *201·5* | — | — | — | — | — | — | — | — | — | — | 1 | 1 | — | 1 | ·5 | — | 1 | 1·5 | 1·5 | — | 1 | — | 8·5 |
| *203·5* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 | — | — | 2 |
| *205·5* | — | — | — | — | — | — | — | — | 1 | — | — | 1 | 1 | — | — | — | — | — | — | — | — | — | 3 |
| Totals | 2 | 2·5 | 4 | 24 | 44 | 53·5 | 90·5 | 150 | 186 | 230 | 295·5 | 238·5 | 217·5 | 189·5 | 166 | 89 | 61·5 | 38 | 18·5 | 8·5 | 2 | 3 | 2114 |

F (ii).

*Head Length reduced to 12 years. Sister-Sister.*

First Sister.

| Second Sister. | 159·5 | 161·5 | 163·5 | 165·5 | 167·5 | 169·5 | 171·5 | 173·5 | 175·5 | 177·5 | 179·5 | 181·5 | 183·5 | 185·5 | 187·5 | 189·5 | 191·5 | 193·5 | 195·5 | 197·5 | 199·5 | 201·5 | 203·5 | Totals | 3 | 2 | 3 | 27·5 | 40·5 | 53·5 | 102 | 128 | 179 | 244·5 | 255 | 239·5 | 223·5 | 174 | 150 | 86 | 37 | 22 | 21 | 6 | 3 | 1·5 | ·5 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 159·5 | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 | | | | | | | | | | | | | | | | | | | | | | | |
| | 161·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | | | | | | | | | | | | | | | | | | | | | | | |
| | 163·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | | |
| | 165·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 | | | | | | | | | | | | | | | | | | | | | | | |
| | 167·5 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 27·5 | | | | | | | | | | | | | | | | | | | | | | | |
| | 169·5 | — | — | — | 5 | 2·5 | 3 | 5 | 8·25 | 10·25 | 9·25 | 11 | 17 | 38 | 34 | 24·5 | 18 | 38·5 | 28 | 15 | 20 | 31 | 28·5 | 23·5 | 19 | 15 | 12·25 | 5·25 | 2 | — | — | — | — | — | — | 40·5 | | | | | | | | | | | |
| | 171·5 | 2 | — | — | 2 | 3·5 | 5 | 8·25 | 21·5 | 9·25 | 9·25 | 11 | 17 | 38 | 34 | 24·5 | 18 | 38·5 | 28 | 15 | 20 | 31 | 28·5 | 23·5 | 19 | 15 | 12·25 | 5·25 | 2 | — | — | — | — | — | — | 53·5 | | | | | | | | | | | |
| | 173·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | | |
| | 175·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | | |
| | 177·5 | — | — | — | 4 | 2·5 | 3 | 4 | 8·25 | 10·25 | 9·25 | 11 | 17 | 38 | 34 | 24·5 | 18 | 38·5 | 28 | 15 | 20 | 31 | 28·5 | 23·5 | 19 | 15 | 12·25 | 5·25 | 2 | — | — | — | — | — | — | 102 | | | | | | | | | | | |
| | 179·5 | — | — | 1 | 4 | 10 | 3 | 13·5 | 22·5 | 34 | 25 | 33·5 | 41 | 36·5 | 33 | 32·5 | 26 | 28·5 | 23·5 | 19 | 15 | 12·25 | 5·25 | 2 | — | — | — | — | — | — | — | — | — | — | — | 128 | | | | | | | | | | |
| | 181·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | |
| | 183·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | |
| | 185·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | |
| | 187·5 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | |
| | 189·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | |
| | 191·5 | — | — | — | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | |
| | 193·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | |
| | 195·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | |
| | 197·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | |
| | 199·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | |
| | 201·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | |
| | 203·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | | | | | | | | | | | | | | | | | | |
| | Totals | 3 | 2 | 3 | 27·5 | 40·5 | 53·5 | 102 | 128 | 179 | 244·5 | 255 | 239·5 | 223·5 | 174 | 150 | 86 | 37 | 22 | 21 | 6 | 3 | 1·5 | ·5 | 2002 | | | | | | | | | | | | | | | | | | | | | | |

F (iii).

*Head Length reduced to 12 years. Brother-Sister.*

Brother.

| Sister. | 163·5 | 165·5 | 167·5 | 169·5 | 171·5 | 173·5 | 175·5 | 177·5 | 179·5 | 181·5 | 183·5 | 185·5 | 187·5 | 189·5 | 191·5 | 193·5 | 195·5 | 197·5 | 199·5 | 201·5 | 203·5 | 205·5 | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 159·5 | — | 1 | ·5 | — | — | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 3·5 |
| 161·5 | — | ·5 | ·5 | — | — | — | — | 1 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 4 |
| 163·5 | — | ·5 | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2·5 |
| 165·5 | — | 1 | — | 1·75 | 1·75 | 2 | 1 | 1 | 1 | — | 1 | — | — | 3 | — | — | — | — | — | — | — | — | 13·5 |
| 167·5 | — | 1 | — | ·25 | 2·25 | 3 | 1 | 1 | 1·5 | 3·5 | 4 | 3 | 2 | — | — | — | — | — | — | — | — | — | 22·5 |
| 169·5 | 1 | 2 | 1 | 2 | — | — | 2 | 4·5 | 2·5 | 4 | 2 | 4 | 1 | 1 | — | — | — | — | 1 | — | — | — | 28 |
| 171·5 | — | 2 | — | — | 4 | 3·5 | 4·5 | 4·75 | 1·75 | 1·5 | 4·5 | 4 | 4·5 | — | 1 | — | — | — | — | — | — | — | 36 |
| 173·5 | — | — | — | ·5 | 3·5 | 5 | 4·5 | 5·75 | 7·75 | 9 | 8 | 5 | 4 | 2·5 | 2·5 | ·5 | — | — | — | — | 1 | — | 59·5 |
| 175·5 | — | — | — | 1 | 2 | 1 | 6·5 | 7·5 | 12·5 | 16 | 15·5 | 9·25 | 6·75 | 6 | 5 | 2·5 | — | — | 1 | — | — | — | 92·5 |
| 177·5 | — | — | — | ·5 | 1·5 | 5 | 3 | 10 | 16 | 11 | 13 | 10·75 | 11·75 | 12 | 2 | 4·5 | — | — | — | — | — | — | 101 |
| 179·5 | — | — | — | — | 1 | 4 | 5 | 3·5 | 9·25 | 18·25 | 15·5 | 22 | 9 | 9 | 2·5 | 4 | 3 | ·5 | 1·5 | — | — | 1 | 109 |
| 181·5 | — | — | — | — | 1 | 2 | ·5 | 5 | 5·75 | 8·25 | 16·25 | 14·75 | 10·5 | 11 | 1·5 | 1·25 | ·25 | 1 | 1 | — | — | — | 80 |
| 183·5 | — | — | — | 1 | 2 | 1·5 | 1 | 5 | 6·5 | 7·75 | 9·5 | 14·25 | 9·5 | 14·5 | 5 | 5·25 | 2·75 | ·5 | — | — | — | — | 86 |
| 185·5 | — | — | — | — | 1 | 2 | 1 | 1 | 4·5 | 1·75 | 2·75 | 12·5 | 11 | 9 | 3·5 | 4 | 3 | 1·5 | — | — | — | — | 58·5 |
| 187·5 | — | — | — | — | — | — | — | — | 1 | 1 | 2·75 | 3·75 | 5·5 | 10 | 6 | 3 | 1·5 | 1·5 | 1·5 | — | — | — | 37·5 |
| 189·5 | — | — | — | — | — | — | 1 | — | 1 | 2 | 2·75 | 4·25 | 2 | 1·5 | 4 | 4 | 1 | 1 | ·5 | — | — | — | 25 |
| 191·5 | — | — | — | — | 1 | — | 1 | — | — | — | 1 | 1 | 2 | 3 | 1 | 2·5 | 2·5 | 4 | ·5 | — | — | — | 19·5 |
| 193·5 | — | — | — | — | 1 | — | — | 1 | — | — | — | 1 | — | 1 | 1 | — | — | ·5 | — | — | — | — | 5·5 |
| 195·5 | — | — | — | — | — | — | — | — | 1 | 1 | 1 | 1 | — | — | ·5 | ·5 | 1 | 1 | — | — | — | — | 7 |
| 197·5 | — | — | — | — | — | — | — | — | — | — | 1 | — | — | 2 | — | — | — | — | — | — | 1 | — | 4 |
| Totals | 1 | 8 | 3 | 7 | 22 | 31 | 32 | 52 | 73 | 86 | 100·5 | 110·5 | 79·5 | 85·5 | 35·5 | 32 | 15 | 11·5 | 7 | 0 | 2 | 1 | 795 |

G (i).

*Head Breadth reduced to 12 years. Brother-Brother.*

First Brother.

| | 122·5 | 124·5 | 126·5 | 128·5 | 130·5 | 132·5 | 134·5 | 136·5 | 138·5 | 140·5 | 142·5 | 144·5 | 146·5 | 148·5 | 150·5 | 152·5 | 154·5 | 156·5 | 158·5 | 160·5 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 122·5 | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| 124·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 0 |
| 126·5 | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| 128·5 | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 8 |
| 130·5 | — | — | — | — | 10 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 22 |
| 132·5 | — | — | — | 2 | — | 4 | 3 | 1 | 2 | 2 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | — | — | — | 26 |
| 134·5 | 1 | — | — | 1 | 1 | 3 | 6 | 1 | 4 | 2 | 7 | 4 | 1 | 1 | 1 | 1 | 1 | — | — | — | 47 |
| 136·5 | — | — | — | 1 | 6 | 9 | 5 | 4 | 17 | 9 | 11 | 10 | 9 | 6 | 4 | 2 | 1 | — | — | — | 86 |
| 138·5 | — | — | — | — | — | 2 | 5 | 17 | 14 | 23 | 23 | 23 | 11 | 5 | 5 | 4 | 1 | — | — | — | 127 |
| 140·5 | — | — | — | — | 2 | 4 | 7 | 11 | 23 | 46 | 35 | 36 | 10 | 4 | 10 | 8 | 2 | — | — | — | 228 |
| 142·5 | — | — | — | 2 | — | — | 4 | 10 | 23 | 35 | 36 | 45 | 23 | 18 | 15 | 14 | 2 | — | — | — | 247·5 |
| 144·5 | — | — | — | — | — | — | 3 | 9 | 18 | 36·5 | 45 | 50 | 35·5 | 33 | 23·25 | 13·25 | ·5 | — | — | 1 | 279 |
| 146·5 | — | — | — | — | 1 | 1 | 3 | 9 | 18 | 36·5 | 45 | 39·5 | 39·5 | 33 | 23·25 | 28·25 | — | — | — | — | 274 |
| 148·5 | — | — | — | — | 1 | 1 | 2 | 9 | 6 | 27·5 | 35·5 | 39·5 | 27·5 | 33 | 23·25 | 28·25 | — | — | — | — | 290 |
| 150·5 | — | — | — | — | — | — | 2 | 2 | 5 | 22 | 32 | 43 | 44 | 66 | 37·5 | 21·5 | 20 | 5 | — | 1 | 290 |
| 152·5 | — | — | — | — | — | — | 1 | 2 | 4 | 10 | 15 | 23·25 | 29·75 | 37·5 | 36 | 23·5 | 8·5 | 10·5 | 5 | 1 | 207 |
| 154·5 | — | — | — | — | — | — | 2 | 1 | 4 | 1 | 8 | 13·25 | 28·25 | 21·5 | 23·5 | 14 | 11·5 | 6·5 | 2 | 1 | 137·5 |
| 156·5 | — | — | — | — | — | — | — | — | 1 | 1 | 2 | 4·5 | 7·5 | 20 | 8·5 | 11·5 | 8 | 3 | — | 4 | 71 |
| 158·5 | — | — | — | — | — | — | — | — | 1 | — | — | ·5 | — | — | 10·5 | 6·5 | 3 | 2 | 5 | — | 35·5 |
| 160·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 5 | 2 | — | 5 | 4 | 3 | 19·5 |
| Totals | 1 | 0 | 1 | 8 | 22 | 26 | 47 | 86 | 127 | 228 | 247·5 | 279 | 274 | 290 | 207 | 137·5 | 71 | 35·5 | 19·5 | 13 | 2120 |

Second Brother.

G (ii).

*Head Breadth reduced to 12 years. Sister-Sister.*

First Sister.

Second Sister.

| | 113·5 | 115·5 | 117·5 | 119·5 | 121·5 | 123·5 | 125·5 | 127·5 | 129·5 | 131·5 | 133·5 | 135·5 | 137·5 | 139·5 | 141·5 | 143·5 | 145·5 | 147·5 | 149·5 | 151·5 | 153·5 | 155·5 | 157·5 | 159·5 | 161·5 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *118·5* | — | — | — | 1 | — | — | — | — | ·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1·5 |
| *116·5* | — | — | — | 1 | — | — | — | — | ·5 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 3·5 |
| *117·5* | — | — | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 4·5 |
| *119·5* | 1 | 1 | 1 | — | 1 | 1 | — | — | — | ·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 15 |
| *121·5* | — | — | 1 | 1 | 4 | 1 | 1 | — | — | 4·5 | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | 12·5 |
| *123·5* | — | 1 | — | 1 | 1 | 1 | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 12 |
| *125·5* | — | — | — | — | 1 | 1 | 1 | — | — | 2·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 18·5 |
| *127·5* | — | — | — | — | — | ·5 | 2·5 | 1 | — | 2·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 20 |
| *129·5* | ·5 | — | — | — | — | 4 | 3·5 | — | 1 | 1·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 47 |
| *131·5* | — | — | ·5 | 4·5 | — | — | 2 | 1 | 5 | 4 | 6 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 88·5 |
| *133·5* | — | — | — | 1 | 2·5 | 1·5 | — | — | 2·5 | 1·5 | 12 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 99 |
| *135·5* | — | — | — | ·5 | — | — | ·75 | 3·25 | 3·5 | 8·75 | 9·75 | 9·75 | 15·25 | 9·75 | 11·75 | 8 | 1 | — | — | — | — | — | — | — | — | 117·5 |
| *137·5* | — | — | — | — | — | — | 3·25 | 3·5 | 8·75 | 9·75 | 13·5 | 21·5 | 21·5 | 21·75 | 9·75 | 15·5 | 5 | 4 | 1·5 | 1 | — | — | — | — | — | 217 |
| *139·5* | — | — | — | — | — | — | 4 | 7·5 | 9·75 | 15·25 | 21·5 | 61 | 36·5 | 1 | — | 2 | 2·5 | 3·5 | 2·5 | 1 | — | — | — | — | — | 239 |
| *141·5* | — | — | — | — | — | — | — | — | 4·5 | 9·75 | 21·75 | 36·5 | 34 | 4·5 | 2 | 5·5 | 3·5 | 1·5 | 2·5 | 2 | — | — | — | — | — | 250·5 |
| *143·5* | — | — | — | — | — | — | — | — | — | 7·5 | 9·75 | 27·75 | 41 | 9 | 5·5 | 1·5 | 1 | 2·5 | 1·5 | 1 | — | — | — | — | — | 268 |
| *145·5* | — | — | — | — | — | — | — | — | — | — | 15·5 | 23·75 | 38·5 | 4·5 | 41·75 | 50 | 28 | 23 | 29 | 2 | — | — | — | — | — | 174 |
| *147·5* | — | — | — | — | — | — | — | — | — | — | — | 8·5 | 17·5 | 19 | 28·5 | 28 | 31·5 | 29 | 15·75 | 11 | 6 | 1 | — | — | — | 152 |
| *149·5* | — | — | — | — | — | — | — | — | — | — | 5 | 4 | 1·5 | 2·5 | 10·5 | 16·25 | 29 | 18 | 11 | 6 | 4·5 | 2 | — | — | — | 81 |
| *151·5* | — | — | — | — | — | — | — | — | — | — | 3 | 1·5 | 2·5 | 1 | 2 | 1 | 16·25 | 11 | 6 | 4·5 | 1 | — | — | — | — | 30·5 |
| *153·5* | — | — | — | — | — | — | — | — | — | — | ·5 | ·5 | — | 1 | 1 | 2 | 4·25 | 6·25 | 15·75 | 6 | 3 | 1 | — | — | — | 19 |
| *155·5* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 6·25 | 1·25 | 6·25 | 4·5 | 1·5 | ·5 | — | — | — | 3·5 |
| *157·5* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2·25 | 1·25 | ·5 | ·5 | ·5 | — | — | — | — | 3 |
| *159·5* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1·25 | ·25 | 2 | — | — | — | — | — | — | 2 |
| *161·5* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | 1 |
| Totals | 1·5 | 3·5 | 4·5 | 15 | 12·5 | 12 | 18·5 | 20 | 47 | 88·5 | 99 | 117·5 | 217 | 239 | 250·5 | 268 | 174 | 152 | 81 | 30·5 | 19 | 3·5 | 3 | 2 | 1 | 1880 |

G (iii).

*Head Breadth reduced to 12 years. Brother-Sister.*

Brother.

| Sister. | 122·5 | 124·5 | 126·5 | 128·5 | 130·5 | 132·5 | 134·5 | 136·5 | 138·5 | 140·5 | 142·5 | 144·5 | 146·5 | 148·5 | 150·5 | 152·5 | 154·5 | 156·5 | 158·5 | 160·5 | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *121·5* | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| *123·5* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 0 |
| *125·5* | 1 | — | — | 3 | — | 1 | 1 | 1 | 2 | — | — | — | — | — | — | — | — | — | — | — | 9 |
| *127·5* | 1 | — | — | 1 | 1 | 1 | — | 1 | ·5 | — | — | — | 1 | — | — | — | — | — | — | — | 6·5 |
| *129·5* | — | — | — | 1 | — | — | 5·5 | 2 | 1·5 | 2·5 | 1 | 2·5 | 2 | ·5 | — | — | — | — | — | — | 18·5 |
| *131·5* | — | — | — | ·5 | ·5 | 1 | 1·5 | 3 | 5 | 7·5 | ·5 | 4 | 1 | 2·5 | — | 1 | 1 | 1 | — | — | 29·5 |
| *133·5* | — | — | — | 1 | — | — | 9 | 2·5 | 9 | 6 | 7·5 | 1·5 | 3 | 3 | — | — | — | — | — | — | 43 |
| *135·5* | — | — | — | — | 1 | 3 | 4 | 6·5 | 9·5 | 7·5 | 8·5 | 9·5 | 8·5 | 2 | — | 1 | — | — | — | — | 61 |
| *137·5* | — | — | — | — | ·5 | 1 | 4·5 | 11 | 8·5 | 15·5 | 15 | 12 | 8 | 11·5 | 2 | 2 | 1·5 | — | — | — | 93 |
| *139·5* | — | — | — | — | 1·5 | — | 2·5 | 2·5 | 7·5 | 15·5 | 23 | 19·5 | 17 | 4·5 | 6·25 | 4·25 | ·5 | 1 | — | — | 105·5 |
| *141·5* | — | — | — | 1 | — | — | — | 5·5 | 8 | 12·5 | 21 | 22 | 13·5 | 10 | 11·25 | 4·25 | 2·5 | — | — | — | 111·5 |
| *143·5* | — | — | — | ·5 | 1·5 | — | 2 | 3·5 | 5 | 12·5 | 10·5 | 5 | 9 | 18 | 10·5 | 5 | 4 | 1 | — | 1 | 89 |
| *145·5* | — | — | — | — | — | — | — | ·5 | 1 | 7·5 | 8 | 6 | 14 | 11 | 11·5 | 7·5 | 4·5 | 1 | 4 | — | 76·5 |
| *147·5* | — | — | — | — | — | — | — | — | 3 | 2 | 3·5 | 4 | 6·5 | 14·5 | 13 | 5 | 5 | 3 | 1 | — | 60·5 |
| *149·5* | — | — | — | — | — | 1 | — | — | 1 | ·5 | 1 | 2 | 4 | 7·25 | 4·25 | 2·5 | 1 | 2 | ·5 | 1 | 28 |
| *151·5* | — | — | — | — | — | — | — | — | — | — | — | 2·5 | 2 | 1·25 | 3·25 | ·5 | 2 | 2 | 1·5 | — | 15 |
| *153·5* | — | — | — | — | — | — | — | — | — | 1 | — | ·5 | 1 | — | 1·5 | 2 | 1 | — | — | — | 7 |
| *155·5* | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | ·5 | — | — | — | — | 1 | 2·5 |
| *157·5* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | ·5 | — | — | — | — | ·5 |
| *159·5* | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | ·5 | — | — | — | — | 1·5 |
| Totals ... | 2 | 0 | 0 | 8 | 6 | 8 | 20 | 40 | 61·5 | 91·5 | 99·5 | 92 | 90·5 | 86 | 64 | 36 | 23 | 10 | 8 | 3 | 759 |

H (i).

*Head Height reduced to* 12 *years. Brother-Brother.*

First Brother.

| Second Brother. | 104·5 | 106·5 | 108·5 | 110·5 | 112·5 | 114·5 | 116·5 | 118·5 | 120·5 | 122·5 | 124·5 | 126·5 | 128·5 | 130·5 | 132·5 | 134·5 | 136·5 | 138·5 | 140·5 | 142·5 | 144·5 | 146·5 | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104·5 | — | — | ·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | ·5 |
| 106·5 | — | — | ·5 | — | — | — | — | 1 | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 2·5 |
| 108·5 | ·5 | ·5 | — | — | — | — | 1 | ·5 | ·5 | — | — | — | 1 | — | — | — | — | — | — | — | — | — | 4 |
| 110·5 | — | — | — | 1 | ·5 | ·5 | 2 | 1·5 | 3·5 | ·5 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | 11·5 |
| 112·5 | — | — | — | ·5 | 2 | — | 2 | 1 | 3·5 | ·5 | — | — | 1 | 1 | — | — | — | — | — | — | — | — | 11·5 |
| 114·5 | — | — | — | ·5 | — | 2 | 8·75 | 4·25 | 3 | 4·25 | 4·25 | 1 | — | ·5 | 1 | 1 | — | ·5 | — | — | — | — | 31 |
| 116·5 | — | — | 1 | 2 | 2 | 8·75 | 8·5 | 14·25 | 10·5 | 8 | 8 | 5 | 6 | 4 | 1·5 | ·5 | 1 | ·5 | — | 1 | — | — | 82·5 |
| 118·5 | — | 1 | ·5 | 1·5 | 1 | 4·25 | 14·25 | 17 | 17 | 16·25 | 17·25 | 15 | 7 | 8 | 3 | 1·5 | — | 1 | — | — | — | — | 125·5 |
| 120·5 | — | — | ·5 | 3·5 | 3·5 | 3 | 10·5 | 17 | 11 | 20·75 | 20·75 | 18·5 | 13·75 | 9·25 | 6·5 | 4·25 | 1·25 | ·5 | — | — | — | — | 144·5 |
| 122·5 | — | — | — | ·5 | ·5 | 4·25 | 8 | 16·25 | 20·75 | 20·5 | 26 | 28·5 | 20 | 13·25 | 8·5 | 3·5 | 6 | ·5 | 3·5 | 1 | — | — | 181·5 |
| 124·5 | — | — | — | 1 | — | 4·25 | 8 | 17·25 | 20·75 | 26 | 33 | 39·5 | 31 | 20·25 | 13 | 10·25 | 3·75 | 1·5 | 1·5 | 2 | — | — | 233 |
| 126·5 | — | 1 | — | 1 | — | 1 | 5 | 15 | 18·5 | 28·5 | 39·5 | 40 | 37·5 | 37 | 26·75 | 14·75 | 3 | 2·5 | 2 | — | — | 1 | 274 |
| 128·5 | — | — | 1 | — | 1 | — | 6 | 7 | 13·75 | 20 | 31 | 37·5 | 27 | 31·25 | 26·75 | 12·75 | 14 | 3·5 | 2·5 | 1·5 | — | — | 236·5 |
| 130·5 | — | — | — | — | 1 | ·5 | 4 | 8 | 9·25 | 13·25 | 20·25 | 37 | 31·25 | 48 | 30·75 | 16·75 | 13 | 11·5 | 5·5 | 1·5 | 2 | — | 253·5 |
| 132·5 | — | — | — | — | — | 1 | 1·5 | 3 | 6·5 | 8·5 | 13 | 26·75 | 26·75 | 30·75 | 23 | 14·75 | 11·75 | 7·25 | 7·5 | 1·5 | 1 | 1 | 185·5 |
| 134·5 | — | — | — | — | — | 1 | ·5 | 1·5 | 4·25 | 3·5 | 10·25 | 14·75 | 12·75 | 16·75 | 14·75 | 10·5 | 12·25 | 8·25 | 5·5 | ·5 | 2 | — | 119 |
| 136·5 | — | — | — | — | — | — | 1 | — | 1·25 | 6 | 3·75 | 3 | 14 | 13 | 11·75 | 12·25 | 9 | 5·5 | 6·5 | 1·25 | 1·25 | — | 89·5 |
| 138·5 | — | — | — | — | — | ·5 | ·5 | 1 | ·5 | ·5 | 1·5 | 2·5 | 3·5 | 11·57 | 7·25 | 8·25 | 5·5 | 7 | 3·5 | 3·25 | 1·25 | — | 58 |
| 140·5 | — | — | — | — | — | — | — | — | — | 3·5 | 1·5 | 2 | 2·5 | 5·5 | 7·5 | 5·5 | 6·5 | 3·5 | 3 | — | 1 | 1 | 43 |
| 142·5 | — | — | — | — | — | — | 1 | — | — | 1 | 2 | — | 1·5 | 1·5 | 1·5 | ·5 | 1·25 | 3·25 | — | 2 | — | — | 15·5 |
| 144·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | 1 | 2 | 1 25 | 1·25 | 1 | — | — | — | 8·5 |
| 146·5 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | 1 | — | — | — | 1 | — | — | — | 3 |
| Totals | ·5 | 2·5 | 4 | 11·5 | 11·5 | 31 | 82·5 | 125 | 144·5 | 181·5 | 233 | 274 | 236·5 | 253·5 | 185·5 | 119 | 89·5 | 58 | 43 | 15·5 | 8·5 | 3 | 2114 |

H (ii).

*Head Height reduced to* 12 *years. Sister-Sister.*

First Sister.

| Second Sister. | 104·5 | 106·5 | 108·5 | 110·5 | 112·5 | 114·5 | 116·5 | 118·5 | 120·5 | 122·5 | 124·5 | 126·5 | 128·5 | 130·5 | 132·5 | 134·5 | 136·5 | 138·5 | 140·5 | 142·5 | 144·5 | 146·5 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104·5 | — | — | — | — | — | — | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| 106·5 | — | — | — | — | — | 3 | — | — | 2 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 8 |
| 108·5 | — | 1 | 6 | — | 2 | 2 | 5 | 3 | 3 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 24 |
| 110·5 | — | — | — | 6 | — | 8 | 6·5 | 4·5 | 3·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | 33·5 |
| 112·5 | — | — | 2 | — | 2 | 8 | 3 | 4 | 3·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | 34 |
| 114·5 | — | 3 | 2 | 8 | 8 | 10 | 16 | 12 | 8·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | 92·5 |
| 116·5 | — | — | 5 | 3 | 3 | 6·5 | 4·5 | 8·5 | 11·5 | 4·5 | 7 | 13·5 | 3 | 1 | 1 | — | — | — | — | — | — | — | 105 |
| 118·5 | 1 | — | 3 | 4·5 | 4 | 12 | 9·5 | 9 | 19 | 27 | 17·5 | 14 | 10 | 6 | 1 | 3 | 2 | — | — | — | — | — | 143·5 |
| 120·5 | 1 | 2 | 3 | 3·5 | 4·5 | 8·5 | 11·5 | 19 | 32 | 41·5 | 20·5 | 23 | 11 | 14 | 2 | 7 | 3 | — | — | — | — | — | 209 |
| 122·5 | — | — | — | — | — | 11 | 9 | 27 | 41·5 | 31 | 37·5 | 37·5 | 23 | 11 | 2 | 7 | 2 | 1 | — | — | — | — | 235·5 |
| 124·5 | — | 1 | — | 1 | — | 2 | 1 | 2 | 3 | 7 | 5 | 35 | 29·5 | 22·5 | 13·5 | 8·5 | 5 | 4 | 1 | 2 | 1 | — | 227 |
| 126·5 | — | — | 1 | 1 | 1 | 7 | 13·5 | 17·5 | 20·5 | 37·5 | 29·5 | 28 | 21·5 | 13·5 | 12·5 | 14 | 5 | 4 | 2 | — | — | — | 191·5 |
| 128·5 | — | 1 | — | — | 1 | 3 | 3 | 14 | 23 | 23 | 23 | 29·5 | 38 | 19 | 12 | 11 | 2 | 1 | — | 1 | — | — | 168 |
| 130·5 | — | — | 1 | — | — | — | 2 | 6 | 14 | 11 | 21 | 22·5 | 19 | 12 | 11 | 11 | 3 | 1 | 2 | 1 | 1 | — | 120 |
| 132·5 | — | — | — | — | — | — | 1 | 1 | 2 | 7 | 13·5 | 21·5 | 12·5 | 11 | 11 | 5 | 2 | 1 | 2 | 1 | — | 1 | 83·5 |
| 134·5 | — | — | — | — | — | — | 3 | 1 | 2 | 2 | 5 | 9 | 2 | 14 | 11 | 12 | 3 | 2 | 4 | 1 | 1 | — | 74 |
| 136·5 | — | — | — | — | — | — | — | 3 | 7 | 3 | 5 | 2 | 3 | 2 | 11 | 3 | 6 | — | 3 | 1 | — | — | 34 |
| 138·5 | — | — | — | — | — | — | 1 | 2 | 3 | 3 | 3 | 4 | — | — | 3 | 3 | — | 2 | — | 2 | 2 | — | 21 |
| 140·5 | — | — | — | — | — | — | — | 1 | — | — | — | 4 | — | 1 | 2 | 1 | — | 3 | 2 | — | 1 | — | 22 |
| 142·5 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 | 1 | 1 | 1 | 1 | 2 | 1 | — | — | 11 |
| 144·5 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 | 1 | 1 | — | 1 | 2 | — | — | — | 6 |
| 146·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 1 |
| Totals | 2 | 8 | 24 | 33·5 | 34 | 92·5 | 105 | 143·5 | 209 | 235·5 | 227 | 191·5 | 168 | 120 | 83·5 | 74 | 34 | 21 | 22 | 11 | 6 | 1 | 1846 |

H (iii).

*Head Height reduced to* 12 *years. Brother-Sister.*

Brother.

| Sister. | 106·5 | 108·5 | 110·5 | 112·5 | 114·5 | 116·5 | 118·5 | 120·5 | 122·5 | 124·5 | 126·5 | 128·5 | 130·5 | 132·5 | 134·5 | 136·5 | 138·5 | 140·5 | 142·5 | 144·5 | 146·5 | 148·5 | 150·5 | 152·5 | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 106·5 | — | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| 108·5 | 1 | — | 1 | 1 | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 4 |
| 110·5 | — | 1 | 2 | — | 1 | 2 | 1 | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 9 |
| 112·5 | — | — | — | 1 | 3·5 | ·5 | ·5 | 4·5 | 2 | 2 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 15 |
| 114·5 | 1 | — | — | — | 4 | 3 | 1·5 | 5 | 6·75 | 2·25 | 3·5 | ·5 | — | — | — | — | — | — | — | — | — | — | — | 1 | 27·5 |
| 116·5 | — | 1 | 1 | 1 | 1 | — | 2 | 6 | 2·25 | 3·75 | 4·5 | 5 | 3 | 1 | — | — | — | 1 | — | — | — | — | — | — | 33·5 |
| 118·5 | 1 | — | ·5 | 1·5 | — | 4·5 | 4 | 5 | 6 | 5 | 3 | 6 | 4 | 5 | 1 | — | 2·5 | 1 | — | — | — | — | — | — | 50 |
| 120·5 | — | — | 5 | ·5 | 2 | 3·5 | 3 | 9·5 | 8 | 11·5 | 5·5 | 8 | 11·5 | 2·5 | 1 | 1 | ·5 | — | — | — | — | 1 | — | — | 69·5 |
| 122·5 | — | — | — | 1 | 2·5 | 3 | 5·5 | 13·5 | 13·5 | 13 | 12 | 11 | 10·5 | 4 | 4 | 4 | 2 | 3 | 1 | — | — | — | — | — | 103·5 |
| 124·5 | — | — | — | 2 | — | 2 | 8 | 8 | 11·5 | 11 | 16 | 10 | 14 | 5 | 7·5 | 6 | ·5 | 2·5 | 1·5 | ·5 | — | — | — | — | 106 |
| 126·5 | — | — | — | — | 1 | 2 | 3·5 | 4·5 | 6·5 | 13·5 | 21 | 12 | 16 | 12 | 2 | 3 | 1 | 1 | 2 | — | — | — | — | — | 101 |
| 128·5 | — | — | — | — | 1 | 1 | 3 | 2 | 1 | 4·5 | 10·5 | 12 | 15·5 | 12·5 | 5 | 6 | 2 | 7 | 1 | ·5 | ·5 | — | — | — | 85 |
| 130·5 | — | — | — | — | — | — | — | 1 | 2 | 3 | 6 | 10 | 9 | 7·5 | 3 | 5·5 | 1 | 2·5 | ·5 | 1 | — | — | — | — | 52 |
| 132·5 | — | — | — | — | — | 1 | — | 1 | 1 | 3·5 | 3·5 | 4·5 | 6·5 | 7 | 5 | 3 | 1 | — | 2·5 | 2·5 | — | — | — | — | 42 |
| 134·5 | — | — | — | — | — | — | — | — | — | 4 | 3 | 6 | 5 | 6 | 2 | — | 4·5 | 1·5 | 2 | — | — | — | — | — | 34 |
| 136·5 | — | — | — | — | — | — | — | — | — | 1·5 | 2·5 | 1 | 1 | 1 | — | 1 | 1 | — | 1 | — | — | — | — | — | 10 |
| 138·5 | — | — | — | — | — | — | — | 1 | — | 1 | — | 1 | 1 | 1 | 1·5 | ·5 | 3 | 1 | 1 | — | — | — | — | — | 12 |
| 140·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | — | — | — | 2 |
| 142·5 | — | — | — | 1 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 2 | — | — | — | — | — | 4 |
| 144·5 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 | — | — | — | — | — | — | — | — | — | 2 |
| Totals | 3 | 3 | 5 | 10 | 16 | 22·5 | 32 | 61 | 61·5 | 81·5 | 91 | 88 | 98 | 65·5 | 33 | 30 | 19 | 22·5 | 14·5 | 4·5 | ·5 | 1 | 0 | 1 | 764 |

ATHLETIC CAPACITY.

I (i). *Brother-Brother.*

First Brother.

| Second Brother. | Athletic. | Betwixt. | Non-athletic. | Totals. |
|---|---|---|---|---|
| Athletic .... .... | 906 | 20 | 140 | 1066 |
| Betwixt .... .... | 20 | 76 | 9 | 105 |
| Non-athletic .... ... | 140 | 9 | 370 | 519 |
| Totals .... .... | 1066 | 105 | 519 | 1690 |

I (ii). *Sister-Sister.*

First Sister.

| Second Sister. | Athletic. | Betwixt. | Non-athletic. | Totals. |
|---|---|---|---|---|
| Athletic .... .... | 638 | 15 | 153 | 806 |
| Betwixt .... .... | 15 | 16 | 11 | 42 |
| Non-athletic .... .... | 153 | 11 | 452 | 616 |
| Totals .... .... | 806 | 42 | 616 | 1464 |

I (iii). *Brother-Sister.*

Brother.

| Sister. | Athletic. | Betwixt. | Non-athletic. | Totals. |
|---|---|---|---|---|
| Athletic .... .... | 195 | 5 | 43 | 243 |
| Betwixt .... .... | 5 | 2 | 2 | 9 |
| Non-athletic .... .... | 91 | 5 | 86 | 182 |
| Totals .... .... | 291 | 12 | 131 | 434 |

## II. PSYCHICAL CHARACTERS. DETAILED TABLES.

### VIVACITY.

J (i). *Brother-Brother.*

First Brother.

| Second Brother. | Quiet. | Noisy. | Totals. |
|---|---|---|---|
| Quiet ... ... ... | 917 | 292·5 | 1209·5 |
| Noisy ... ... ... | 292·5 | 350 | 642·5 |
| Totals ... ... | 1209·5 | 642·5 | 1852 |

J (ii). *Sister-Sister.*

First Sister.

| Second Sister. | Quiet. | Noisy. | Totals. |
|---|---|---|---|
| Quiet ... ... ... | 1013 | 349 | 1362 |
| Noisy ... ... ... | 349 | 393 | 742 |
| Totals ... ... | 1362 | 742 | 2104 |

J (iii). *Brother-Sister.*

Brother.

| Sister. | Quiet. | Noisy. | Totals. |
|---|---|---|---|
| Quiet ... ... ... | 360·25 | 164·25 | 524·5 |
| Noisy ... ... ... | 79·25 | 148·25 | 227·5 |
| Totals ... ... | 439·5 | 312·5 | 752 |

ASSERTIVENESS.

K (i). *Brother-Brother.*

First Brother.

| Second Brother. | Shy. | Self-assertive. | Totals. |
|---|---|---|---|
| Shy ... ... ... | 679 | 247 | 926 |
| Self-assertive ... ... | 247 | 399 | 646 |
| Totals ... ... | 926 | 646 | 1572 |

K (ii). *Sister-Sister.*

First Sister.

| Second Sister. | Shy. | Self-assertive. | Totals. |
|---|---|---|---|
| Shy ... ... ... | 672 | 296 | 968 |
| Self-assertive ... ... | 296 | 436 | 732 |
| Totals ... ... | 968 | 732 | 1700 |

K (iii). *Brother-Sister.*

Brother.

| Sister. | Shy. | Self-assertive. | Totals. |
|---|---|---|---|
| Shy ... ... ... | 241 | 114 | 355 |
| Self-assertive ... ... | 70·5 | 147·5 | 218 |
| Totals ... ... | 311·5 | 261·5 | 573 |

L (i). INTROSPECTION.

*Brother-Brother.*

First Brother.

| Second Brother. | Self-conscious. | Unself-conscious. | Totals. |
|---|---|---|---|
| Self-conscious ... ... | 600 | 245 | 845 |
| Unself-conscious ... | 245 | 550 | 795 |
| Totals ... ... | 845 | 795 | 1640 |

L (ii). *Sister-Sister.*

First Sister.

| Second Sister. | Self-conscious. | Unself-conscious. | Totals. |
|---|---|---|---|
| Self-conscious ... ... | 561 | 302·5 | 863·5 |
| Unself-conscious ... | 302·5 | 588 | 890·5 |
| Totals ... ... | 863·5 | 890·5 | 1754 |

L (iii). *Brother-Sister.*

Brother.

| Sister. | Self-conscious. | Unself-conscious. | Totals. |
|---|---|---|---|
| Self-conscious ... ... | 126·25 | 210·25 | 336·5 |
| Unself-conscious ... | 253·75 | 66·75 | 320·5 |
| Totals ... ... | 380 | 277 | 657 |

POPULARITY.

M (i). *Brother-Brother.*

First Brother.

| Second Brother. | Popular. | Unpopular. | Totals. |
|---|---|---|---|
| Popular... ... ... | 1107·5 | 185·5 | 1293 |
| Unpopular ... ... | 185·5 | 147·5 | 333 |
| Totals ... ... | 1293 | 333 | 1626 |

M (ii). *Sister-Sister.*

First Sister.

| Second Sister. | Popular. | Unpopular. | Totals. |
|---|---|---|---|
| Popular... ... ... | 1133·5 | 182·5 | 1316 |
| Unpopular ... ... | 182·5 | 175·5 | 358 |
| Totals ... ... | 1316 | 358 | 1674 |

M (iii). *Brother-Sister.*

Brother.

| Sister. | Popular. | Unpopular. | Totals. |
|---|---|---|---|
| Popular... ... ... | 432·75 | 54·25 | 487 |
| Unpopular ... ... | 40·75 | 26·25 | 67 |
| Totals ... ... | 473·5 | 80·5 | 554 |

CONSCIENTIOUSNESS.

N (i). *Brother-Brother.*

First Brother.

| Second Brother. | Keen. | Dull. | Totals. |
|---|---|---|---|
| Keen ... ... ... | 970 | 216·5 | 1186·5 |
| Dull ... ... ... | 216·5 | 287 | 503·5 |
| Totals .. ... | 1186·5 | 503·5 | 1690 |

N (ii). *Sister-Sister.*

First Sister.

| Second Sister. | Keen. | Dull. | Totals. |
|---|---|---|---|
| Keen ... ... ... | 1071·5 | 201 | 1272·5 |
| Dull ... ... ... | 201 | 278·5 | 479·5 |
| Totals ... ... | 1272·5 | 479·5 | 1752 |

N (iii). *Brother-Sister.*

Brother.

| Sister. | Keen. | Dull. | Totals. |
|---|---|---|---|
| Keen ... ... ... | 366·75 | 122·75 | 489·5 |
| Dull ... ... ... | 59·75 | 136·75 | 196·5 |
| Totals ... ... | 426·5 | 259·5 | 686 |

TEMPER.

O (i). *Brother-Brother.*

First Brother.

| Second Brother | Quick. | Good-natured. | Sullen. | Totals. |
|---|---|---|---|---|
| Quick ... ... | 138·5 | 152·25 | 39·75 | 330·5 |
| Good-natured ... | 152·25 | 1026·5 | 106·25 | 1285 |
| Sullen ... ... | 39·75 | 106·25 | 84·5 | 230·5 |
| Totals ... ... | 330·5 | 1285 | 230·5 | 1846 |

O (ii). *Sister-Sister.*

First Sister.

| Second Sister. | Quick. | Good-natured. | Sullen. | Totals. |
|---|---|---|---|---|
| Quick ... ... | 198 | 177 | 77 | 452 |
| Good-natured ... | 177 | 996 | 165 | 1338 |
| Sullen ... ... | 77 | 165 | 120 | 362 |
| Totals ... ... | 452 | 1338 | 362 | 2152 |

O (iii). *Brother-Sister.*

Brother.

| Sister. | Quick. | Good-natured. | Sullen. | Totals. |
|---|---|---|---|---|
| Quick ... ... | 60 | 45·5 | 10 | 115·5 |
| Good-natured ... | 68·75 | 388 | 43·75 | 500·5 |
| Sullen ... ... | 13·25 | 56·5 | 18·25 | 88 |
| Totals ... ... | 142 | 490 | 72 | 704 |

ABILITY.

P (i). *Brother-Brother.*

First Brother.

| Second Brother. | Quick-intelligent. | Intelligent. | Slow-intelligent. | Slow. | Slow-dull. | Very dull. | Totals. |
|---|---|---|---|---|---|---|---|
| Quick-intelligent | 88 | 62·25 | 42·25 | 11 | 2 | 2 | 207·5 |
| Intelligent .... | 62·25 | 313·5 | 183·75 | 72·5 | 9·5 | 1 | 642·5 |
| Slow-intelligent .... | 42·25 | 183·75 | 255·5 | 73 | 22·5 | 8 | 585 |
| Slow .... .... | 11 | 72·5 | 73 | 97·5 | 39 | 4 | 297 |
| Slow-dull.... .... | 2 | 9·5 | 22·5 | 39 | 28 | 7 | 108 |
| Very dull.... ... | 2 | 1 | 8 | 4 | 7 | 6 | 28 |
| Totals ... .... | 207·5 | 642·5 | 585 | 297 | 108 | 28 | 1868 |

P (ii). *Sister-Sister.*

First Sister.

| Second Sister. | Quick-intelligent. | Intelligent. | Slow-intelligent. | Slow. | Slow-dull. | Very dull. | Totals. |
|---|---|---|---|---|---|---|---|
| Quick-intelligent | 118 | 111 | 49·5 | 14 | 7 | 1 | 300·5 |
| Intelligent .... | 111 | 326 | 213 | 47 | 10 | 5 | 712 |
| Slow-intelligent .... | 49·5 | 213 | 204 | 99·5 | 30 | 9 | 605 |
| Slow .... .... | 14 | 47 | 99·5 | 64 | 29 | 7 | 260·5 |
| Slow-dull.... ... | 7 | 10 | 30 | 29 | 22 | 5 | 103 |
| Very dull.... .... | 1 | 5 | 9 | 7 | 5 | 6 | 33 |
| Totals.... .... | 300·5 | 712 | 605 | 260·5 | 103 | 33 | 2014 |

P (iii). *Brother-Sister.*

Brother.

| Sister. | Quick-intelligent. | Intelligent. | Slow-intelligent. | Slow. | Slow-dull. | Very dull. | Totals. |
|---|---|---|---|---|---|---|---|
| Quick-intelligent | 53 | 39 | 23 | 8 | 5·25 | ·25 | 128·5 |
| Intelligent .... | 51 | 118·5 | 90 | 25 | 11·75 | 5·75 | 302 |
| Slow-intelligent .... | 17 | 77·5 | 119 | 39 | 15 | 5 | 272·5 |
| Slow .... .... | 7 | 28 | 38 | 29 | 7 | 1 | 110 |
| Slow dull .... .... | 2 | 5 | 5 | 5 | 9 | 5 | 31 |
| Very dull.... .... | 1 | 3 | 5 | — | 1 | 6 | 16 |
| Totals.... .... | 131 | 271 | 280 | 106 | 49 | 23 | 860 |

HANDWRITING.

Q (i). *Brother-Brother.*

First Brother.

| Second Brother. | Very good. | Good. | Moderate. | Poor. | Bad. | Very bad. | Totals. |
|---|---|---|---|---|---|---|---|
| Very good .... | 52 | 51 | 27·5 | 3 | 1 | — | 134·5 |
| Good .... ... | 51 | 335 | 224·5 | 32 | 4 | 1 | 647·5 |
| Moderate ... | 27·5 | 224·5 | 406 | 101·5 | 15·5 | 2 | 777 |
| Poor .... ... | 3 | 32 | 101·5 | 96 | 15 | 2 | 249 5 |
| Bad .... ... | 1 | 4 | 15·5 | 15 | 7 | 1 | 43·5 |
| Very bad ... | — | 1 | 2 | 2 | 1 | 4 | 10 |
| Totals .... | 134·5 | 647·5 | 777 | 249·5 | 43·5 | 10 | 1862 |

Q (ii). *Sister-Sister.*

First Sister.

| Second Sister. | Very good. | Good. | Moderate. | Poor. | Bad. | Very bad. | Totals. |
|---|---|---|---|---|---|---|---|
| Very good ... | 50 | 29 | 23 | 5 | — | — | 107 |
| Good .... .... | 29 | 334 | 170 | 36·5 | 6 | — | 575·5 |
| Moderate .... | 23 | 170 | 300 | 90·5 | 17 | 5 | 605·5 |
| Poor .... .... | 5 | 36·5 | 90·5 | 68 | 14 | — | 214 |
| Bad .... .... | — | 6 | 17 | 14 | 10 | 4 | 51 |
| Very bad .... | — | — | 5 | — | 4 | 4 | 13 |
| Totals .... | 107 | 575·5 | 605·5 | 214 | 51 | 13 | 1566 |

Q (iii). *Brother and Sister.*

Brother.

| Sister. | Very good. | Good. | Moderate. | Poor. | Bad. | Very bad. | Totals. |
|---|---|---|---|---|---|---|---|
| Very good .... | 15 | 13 | 7 | 3 | — | — | 38 |
| Good .... .... | 27 | 146·5 | 106·75 | 31·75 | 1 | — | 313 |
| Moderate .... | 9 | 74 | 140·25 | 42·75 | — | 1 | 274 |
| Poor .... .... | — | 13 | 40 | 31 | 4 | 2 | 90 |
| Bad .... .... | — | 2 | 5 | 2 | 2 | — | 11 |
| Very bad .... | — | — | 1 | — | 1 | — | 2 |
| Totals .... | 51 | 248·5 | 300 | 110·5 | 15 | 3 | 728 |

# A STUDY OF THE VARIATION AND CORRELATION OF THE HUMAN SKULL, WITH SPECIAL REFERENCE TO ENGLISH CRANIA.

By W. R. MACDONELL, LL.D.

## (1) *Introductory.*

The following paper is a contribution to the investigation which has been going on for several years at University College, London, under the direction of Professor Karl Pearson, with the view of determining the size, variability, and correlation of various organs and characters in man. Professor G. D. Thane, head of the Anatomical Department in the college, is the fortunate possessor of a collection of human skulls which were discovered in 1893 in Whitechapel, and it is this great series which forms the subject of my inquiry. We have most heartily to thank Professor Thane for unreservedly placing his splendid material at the disposal of the biometric workers in the college. Some of the skulls had been examined by previous observers, and measurements made of a few of the chief characters, with important results to craniology, but a systematic examination of the whole series had still to be accomplished. At Professor Pearson's suggestion I undertook this very attractive piece of work in 1901, and measured all the skulls in accordance, for the most part, with the system of the *Frankfurter Verständigung*, so far as the condition of the material allowed. In the arithmetical reduction of the measurements I have closely followed the scheme adopted by Cicely D. Fawcett in her great paper on Naqada Crania*. A few of my results will be found to differ a little from those previously published; this is due mainly to the inclusion of several skulls which were not available until towards the very end of the inquiry, and to some final correction of measurements; these discrepancies, however, are not very serious.

## (2) *Previous Results for English Skulls.*

These are disappointingly meagre, and a short account of the most important catalogues in which British skulls are described and measured will show the immense relative importance of the Whitechapel series.

* *Biometrika*, Vol. I. pp. 408—467.

J. Barnard Davis' *Thesaurus Craniorum*, a catalogue of the human skulls in his own collection, published in 1867, deals with the skulls of a great variety of races, but contains no important series of any one race. He divides the races of the British Islands into "Ancient British" and "Modern British"; the former he subdivides into Aboriginal, Ancient Roman, and so on, and of these ancient races he catalogues 85 skulls; the latter he subdivides into English, Welsh, Scottish, and Irish. Of his modern British races he has 135 skulls in all, of which 81 are English, male and female, but for some of these no measurements are given, no doubt owing to the imperfection of the material; and while some are really modern, others are obviously hundreds of years old. Davis, when possible, took 18 measurements on each of his skulls, and if he had possessed a larger and more homogeneous series of English skulls he would have placed extremely valuable material at our disposal for purposes of comparison.

Twelve years after the publication of Davis' *Thesaurus*, Sir William Flower issued Part I. of the Osteological Catalogue of the Royal College of Surgeons, dealing with "Homo Sapiens"; in this work 1018 skulls are catalogued, of which only 278 are European, ancient and modern, and of these 278 only 63 are from the British Isles, and range from "Ancient British" to "Modern." Here again there is practically no material for comparison. One of the most important series in the catalogue appears to be that of 114 modern Italians, mostly males, and as 11 measurements were taken, and 5 indices calculated, on each skull when possible, there is in this case a considerable mass of first-class material ready for reduction *.

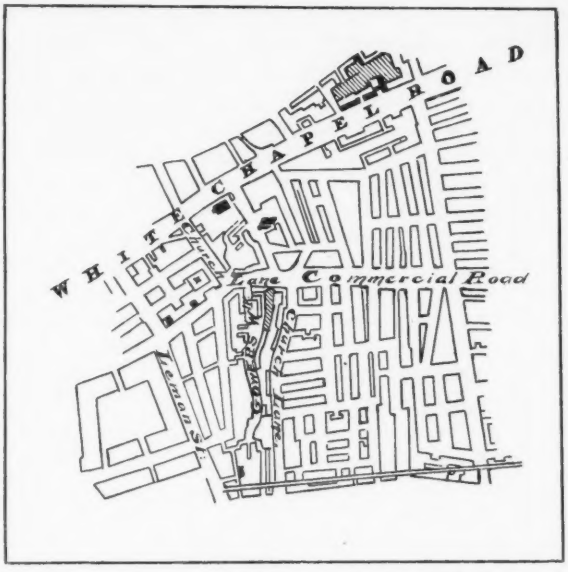
No further work of importance on British craniology appears to have been issued in this country until 1903, when Sir William Turner published, in the *Transactions of the Royal Society of Edinburgh* (Vol. XL. Part III. pp. 547—613), a paper on Scottish skulls. This paper contains the measurements of 176 male and female skulls, and is illustrated by photographs: the number of measurements taken on each skull is no less than 33, and 8 indices are calculated, and the mean and maximum and minimum values of each character are given. The great value of the paper as a contribution to craniological literature is obvious, but unfortunately for our purposes, the skulls which it deals with were obtained from different parts of Scotland, and range from quite unknown antiquity to modern specimens from the dissecting rooms; they cannot, therefore, be considered a homogeneous series, and this conclusion is confirmed by an examination of their variability. For example, I find that the standard deviation of the glabello-occipital length in these Scottish skulls is 7·418 for males and 7·151 for females, which shows a much higher variability than is found in fairly contemporary individuals of homogeneous races †. I shall give later in summarising my results the chief biometric constants of Turner's material.

* See, however, Pearson: *Chances of Death*, Vol. I. pp. 332 and 353.

† See *postea*, p. 206, and *Biometrika*, Vol. II. p. 346.

### (3) *Material and History of the Site**.

The problems which arise here are far more difficult of solution than appeared on the first discovery of the bones. This took place in the second week of October, 1893, while excavations were being made for the foundations of Kinloch's whiskey stores in Whitechapel. The site lies in a blunt-wedge shaped area bounded at present on the North by Commercial Road, on the West by Gower's Walk, on the East by Backchurch Lane, and on the South by Hooper Street. Kinloch's stores are in Backchurch Lane, a fairly large, new building. Another new building in Gower's Walk, but nearer Hooper Street, is Brown and




Map of site, 1847, before Commercial Road was carried through to the Whitechapel Road. St Mary's is under the "C" of "Whitechapel Road." Under the "n" of the horizontal "Lane" is the hatched area which was Sheen's Burial Ground. Between "r" and "c" of the vertical "Church Lane" on the west is the site of Kinloch's, just above the "nick" or bend at the "c." Hooper Street is not marked, but is an east and west road not quite half the distance below Kinloch's that Kinloch's is from the Commercial Road. The old "Bone Yard" is still visible with a narrow neck running into it the bottom of Gower's Walk. To the west of Leman Street, the large square is Goodman's Fields. These fields existed in the 16th century, extending over the whole district south of St Mary's, and Roman cemeteries were discovered in 1787 in, or perhaps slightly east of, and north of this square.

* Owing to Dr Macdonell having left London, I have at his request supplied this section. I have to thank Mr Philip Norman, the staff of the Map Department, British Museum, Mr E. M. Borrajo (of the Guildhall Library), Mr M. Apted of Stepney, and Mr W. Minn of Whitechapel for assistance in this inquiry. My demonstrator Mr W. L. Atcherley kindly investigated the distances. K. P.

Eagle's woollen warehouse. The bulk of my informants agree that the bones were found in excavating for Kinloch's; one states that they were found in building Brown and Eagle's. I think there can be no doubt that the site was under Kinloch's, perhaps half-way back to Gower's Walk. Messrs E. R. Barton and W. H. Peile, who drew up a report at the time and saw the bones *in situ*, state that about 150 to 200 yards down Gower's Walk was a hoarding of boards enclosing about an acre of ground between Gower's Walk and Backchurch Lane, "where a number of houses had been pulled down and excavations commenced for the purpose of laying the foundations of [*blank left*]." The length of Gower's Walk to Hooper Street from Commercial Road is 299 yards and Brown and Eagle's is situated at the bottom, or corner of Hooper Street. Kinloch's building is a little less than 200 yards down Backchurch Lane from Commercial Road. I think therefore that there is no doubt about Kinloch's being the actual site.

Turning to the history of the site, I find that the district, now called Goodman's Fields, was originally far more extensive, and in maps of Roman and Anglo-Saxon London is marked with "Roman cemeteries*." Our skulls, however, are certainly not Roman or Romano-British. Further in plans of London from the reign of Queen Elizabeth, "White Chapel" stands in the fields, and between this and Rosemary Lane west of Cable Street there appears to be nothing in the nature of a church or burial-ground, only open country†. In somewhat later plans‡ I find a lane running up through open fields towards the back of St Mary's Church ("White Chapel"). This lane gradually gets more defined; a first piece, "Church Lane," runs from St Mary's Church not quite south, then a piece, Back Church Street, turns at the back of St Mary's west and east, almost where Commercial Road (so-called in 1803, formerly White Horse Lane) now lies, and lastly a long south piece corresponding to the present Backchurch Lane. This string of three portions continues as Church Street, Church Lane, Backchurch Lane, etc., through a whole series of maps and plans, until the real "back church" lane was destroyed when the Commercial Road was carried through into the Whitechapel Road (1865–70), and the two pieces west of St Mary's and east of Gower's Walk became finally Church Lane and Backchurch Lane. Even as late as 1772 we find the space east of Church Lane occupied by fields or closes; for example in "A New Plan of London and Westminster" from Noortbouch's *History of London*. We may therefore assert that Church Lane from St Mary's south to Cable Street became from a field track a definite road about 1658. About the time of the Great Plague we see it on R. Blome's Plan, 1664, with no west enclosures and in Doornech's Plan, 1666, with long horizontal fields to west. A remarkable "Plan des villes de Londres, etc." 1668, shows smaller closes (but no houses) on the west side of Church

* Darton's Plan of Anglo-Saxon London and Britton's Plan.

† *Londinum, vulgo London*, 1582, and Aggas, 1586, do not extend quite so far; J. Bowles' Plan shows Goodman's Fields stretching east and south of "White Chapel." Rytter, 1604, shows open country. J. Speed, 1610, goes only to the Minories. The "Plan of City of London as fortified by Act of Parliament 1642–3" is not clear but the fortifications seem to cross the site under discussion.

‡ The Lane is not in Walton, 1654, but it is in W. Fairthorne, 1658, and R. Newcourt, 1658.

Lane. If this plan can be trusted, it was absolutely the first spot at which open fields could be reached from Aldgate. It was therefore the very spot most likely to be selected for a pest-field. Now for a short interval at the end of the 17th and beginning of the 18th century the Lane appears running north of "Marine Square" (Wellclose Square), and about half-way down the Lane* on the west side of it (towards what is now Gower's Walk) appears above the nick or bend a small enclosure with apparently two small buildings on it†. This enclosure must have been just where Kinloch's now stands, it may have been a burial-ground or a pest-field with sheds for the pest-carts. It had no existence in the plans of London before the Great Plague; it has disappeared in plans of 1740, while in 1760 we still find fields to the east but houses beginning to the west of the Lane. Finally in 1806 in a *Plan of Cities of London and Westminster* (Lambert's *History of London*) we note Gower's Walk first given by name and a vacant space between this and the houses in Backchurch Lane. Lambert Street, west of Gower's Walk, is given as "Lambe Street" as early as 1742. Thus up to the beginning of 1800 there is no sign of any burial-ground between Backchurch Lane and Gower's Walk. There is, however, as I have already mentioned, a sign of some small enclosure existing in 1688 for a few years. This lasts for about 50 years from the time of the Great Plague (1665–6). We must investigate this a little further. A scale of yards on the plan gives this enclosure between 190 and 200 yards from White Horse Lane—the modern Commercial Road. In other words there is practically not the slightest doubt that Kinloch's is built on the site of this enclosure. If this enclosure had originally been a burial-ground or pest-field, it appears to have lost its

* i.e. half-way from the then "White Horse Lane" (later Commercial Road) which led to "Hangman's Acre," west of Stepney.

† Jean Corvin and C. Mortier, 1688, first give this enclosure above the nick. Of maps between 1665 and 1688, the most important survey, Ogilby's, 1677, stops at the Minories. J. de Ram's Amsterdam map of 1680 gives Church Lane as a straight lane (!), and J. Sellar, 1680, is equally diagrammatic, they indicate fields to west. Later Dutch maps, Jacob de la Feuelle, 1690, Peter van der Aa, 1690, also give no "nick" and the diagrammatic Lane with fields to west. Of maps which show the enclosure I note the following:—R. Morden, P. Lea and C. Browne, 1690; Stridbeck, 1700; Houmann's, ?1700; Lea and Glynne, 1707. Overton's, 1706, shows first a house above nick and his editions give enclosure. John Stowe's map for his survey of 1720 gives this enclosure. I believe this is the last map we can *trust* for the continued existence of the enclosure. It has gone in Rocque's great map of 1735, houses and gardens appearing on the spot. But a whole series of later maps which copy Mortier or Morden and Lea still continue to show it, e.g. Overton, 1731 and 1739; Morden and Lea, 1732; T. Bowles, 1731; John Bowles, 1736; George Foster, 1738; Nürnberg map, 1736; Eliz. Foster, 1752; and even Sayer of 1765! But Rocque of course weighs heavily, as an actual new survey, against all this light material. It is not in T. Taylor, 1723; J. Smith, 1724; or Pine and Tinney, 1744. The "New Survey, London Magazine," 1761, does not show it, but a chain of houses on the west side of Church Lane, and Kitchen and Parker, 1765, show houses beginning to extend round nick. M. Seutter, 1710, shows a triangular-shaped enclosure replacing the irregular quadrilateral of 1688. If correct this was the beginning of the end, but the change escaped John Stowe. Dicey, 1765, shows houses round nick. Marshall, 1782, shows houses at nick, but a gap where Kinloch's now stands; Gower's Walk begins to be visible, looking like a field track. Maps of 1783–1797 show variable but increasing numbers of houses along Church Lane, until in Faden, 1803, we find a continuous belt. Thus between 1730 and 1800 houses sprung up all along the present Backchurch Lane, but the actual site of the supposed pest-field was among the last to be built on.

significance by 1730, when it ceases to be marked on the new surveys. By 1800 it was built over. We might therefore fairly reasonably assume that burials here of whatever kind would date from the latter half of the 17th century, and most probably from the time of the Great Plague.

Turning now to the actual discovery of the bones, we note first that:

(i) No tombstones and coffin furniture were found.

(ii) The skeletons were found scattered with great irregularity, more or less however in rows in shallow trenches. Dr Peile informs me, that he is fairly certain from the manner in which the bones were disposed that they had been placed in position with the flesh upon them.

(iii) The material was very extensive, possibly five to six hundred skeletons.

(iv) Messrs Peile and Barton at first put on one side only those crania of special anatomical interest, but afterwards, the bones having been removed to a railway arch, the whole of the material was procured for scientific study.

(v) The bones were found in made ground, and were said to have been under houses just pulled down, which houses had been built in 1820. If this be so, they must have been originally buried *close* to Backchurch Lane, i.e. where the small enclosure of 1688 existed. Houses, however, certainly existed on the site 20 to 30 years earlier.

(vi) Some of the bones are stained with a green material, looking like salts of copper. No coins except a few Victorian halfpence were admitted by the workmen to have been found.

The conclusion drawn at the time from the evidence then available was that the material had been taken from a plague pit of the 17th century, just a little way from the City gate—Aldgate.

From the standpoint of science it is most heartrending that no proper archaeological enquiry was made at the time. Many points could then have been cleared up which can now be only matter for conjecture.

Now (i) would exclude the idea of a recent burial-ground, although the green stain might possibly be due to "coffin furniture." Some hair was found of various shades, and pieces of what Dr Peile describes as probably "gold lace."

Further (ii) would apparently exclude any removal unless very shortly after interment.

If (v) be certain the bones date from before 1820. In Horwood's map of 1799 houses appear on the site of Kinloch's Stores. Horwood's map also gives a "Bone Yard" at the extreme south of Gower's Walk. Mrs Basil Holmes in her book *The London Burial-Grounds*, 1896, includes (*Appendix*, p. 327) this "Bone Yard, Gower's Walk" among "burial-grounds which have been entirely demolished" for new streets, etc. I suppose she has some authority for supposing this "Bone Yard" to have been a burial-ground, but however this may be, it is entirely away from the site

of Kinloch's excavations. She also speaks of "Pest Field or Plague Pit in Gower's Walk now occupied by Messrs Kinloch's new buildings." I presume, however, that she had no better authority for this view than I have given above from Messrs Barton and Peile's report.

I cannot find that on the discovery of the bones any attention was drawn to the existence within a few yards of the spot of a very crowded burial-ground. This forms the real difficulty of the investigation. I first had my attention drawn to it by examining a very recent map of London published by Gall and Inglis. On this map a long strip running south from the Commercial Road about midway between Gower's Walk and Backchurch Lane is marked "Burial-Ground." At present it appears to be a cartage contractor's mews, paved with cobbles, and without the least sign of a burial-ground at all! Measured on Gall and Inglis' map this ground extends about 91 yards south from the Commercial Road. In Crutchley's map of 1847 it is also marked Burial-Ground and extends between 90 and 100 yards from the west and east section of Church Lane, afterwards taken up by the extension of Commercial Road. This enclosure first appears with the name "burial-ground" in Greenwood's fine map of 1824–6. There is no sign of it in any map I have seen from the beginning of the 19th century and still less from the end of the 18th. It is difficult to conceive that it existed before houses were built on Kinloch's site. In Neele's map of 1806 there is a passage across from Gower's Walk to "Church Street," about half-way down to what is now Hooper Street. It is represented now by an alley with squalid cottages running east from Gower's Walk 148 yards down. It does not go through to Backchurch Lane as it did in 1806. This passage would, we hold, have been north of the Kinloch site, and it seems extremely unlikely that the burial-ground should have crossed it, and originally have extended to Kinloch's site. It was some time before I could identify the burial-ground by name. It belonged to an undertaker named Sheen and was called Sheen's Burial-Ground*. In 1829 I find Sheen was living in Leman

* The cartographic history of Sheen's is the following. We find on the west and east section of Church Lane (now Commercial Road) a "Chapel" and "Burial-Ground" south of it on Greenwood's map of 1824–6. The south end of the ground is 100 to 120 yards from the then Lane. The ground is broader than marked on later maps and more like the present cobbled yard. In Horwood, 1792, there is a close, which obviously became Sheen's. In Bowles of 1786, and his circular map of 1790, there appears to be a house with a garden behind it. Carey, 1787, indicates it too, and I think that this *garden* was Horwood's close which ultimately became Sheen's. It must not be confused with a house and garden—query, chapel and burial-ground—which appear in a very marked way on Laurie and Whittle's map of 1800; Walter, 1801, and possibly Carey, 1766, seem to give this also. It would be west of Sheen's and at the entrance to Great Alie Street. Possibly it was the "Ebenezer Chapel" referred to in a later footnote. In 1823 J. Wyld marks "Chapel" at the spot of chapel on Greenwood, and Thompson, 1823, gives apparently the lines of Sheen's ground. In 1827 Wyld gives the burial-ground unnamed; in 1828, Faden gives "chapel" without ground. In 1826, 1827, 1835 and 1847 Crutchley has "burial-ground." In Faden, Hughes, R. Rowe, Smith, Fores, Darton, Phillips, Mogg, Fairbairn, Langley and Bletch, Luffman, all maps from 1803–1810, it does *not* appear. In Sherwood, Neele and Jones, 1813; Mogg, 1814; Carey, 1818; Leigh, 1820; etc. etc. it is absent. Laurie and Whittle, 1809–10, indicate a dotted close, and Cooke, 1801, a building at the entrance. To sum up, Sheen's as a burial-ground most likely did not exist before 1820 and was probably placed with a chapel on the site of an old house and garden.

Street*, but his business appears afterwards to have been removed to a house near the gate of the ground in Backchurch Lane. Sheen's Burial-Ground was closed April 1, 1854. A witness before the Select Committee on Improvement of Health in Towns in 1842 speaks of it as having been opened "some years ago†." In Chadwick's Report, 1843, it is stated to be 9680 square yards with 600 burials per annum and 300 burials per acre. It was thus a small ground, but if its depth was between 90 and 100 yards, it must have been about 100 yards broad, whereas on the maps after Greenwood it is given as a long thin strip hardly 15 to 20 yards broad. It was thus described by G. A. Walker in his *Gatherings from Grave Yards*, 1839: "This also is a *private* burying-place. The proprietor of this ground is an undertaker. He has planted it with trees and shrubs, which are sufficiently attractive, but the ground is saturated with human putrescence."

Before I leave Walker's terrible survey of the state of the London graveyards in 1839, I must refer to what he terms the "management" of these burial-grounds. Thus he gives on p. 199 an account of a Mile End private burial-ground belonging to an undertaker, where the coffins were dug up, the coffin furniture, nails more especially, sold to "dealers in marine stores," the coffin wood was apparently used as fuel, and the bodies, only interred about a month or six weeks, thrown into a deep hole in an obscure corner of the ground. In this way place was made for fresh interments in the better and more crowded part of the ground. This case was by no means an isolated one. "Management" and "clearance" went on in many of the crowded London graveyards before 1854.

The problem before us then is this: a graveyard (now unrecognised as a cartage contractor's yard) existed some 30 to 50 yards only north of the site where the bones were found. It was densely packed, its southern boundary is not very clearly defined and it appears to have been larger than the marked enclosure of the maps. Could there have existed a clearance pit outside of this graveyard, or could it have extended at some time some distance further south than the maps indicate? If it can now be used as a mews, there is no reason why a portion of it should not have been sold off for building purposes after being filled up in the first half of the nineteenth century. If this had happened our crania would date from 1820 say to 1850. They would belong to the better class of denizens in Whitechapel, i.e. those who could afford to buy a grave and did not exercise their right as parishioners to be buried in St Mary's overcrowded graveyard. It must be remembered that there was a residential population of merchants, commercial men, master-mariners and such like living at that time between the Whitechapel and the Commercial

* "F. Sheen: Coffin plate chaser and Undertaker, 80 Leman Street." He does not appear in the London Directories before this date.

† There was an "Ebenezer Chapel" at the east corner of Gower's Walk and Backchurch Lane, close on to the spot where Little Ayliff Street (now Little Alie Street) runs into the two. One of my local informants tells me that many interments took place at this Chapel: see preceding footnote. This probably accounts for Mrs Basil Holmes' statement that Sheen's ground was used by the Baptists in Little Alie Street and was then called Mr Brittain's burial-ground, "If so it existed in 1763" (*loc. cit.* p. 327). This was possibly the Ebenezer Chapel ground. There is no sign of Sheen's ground on the maps before 1800.

Roads; that in 1829 captains and merchants met in front of the London Hospital to bargain for cargoes, and that from the "New Road," people still living can remember before 1840 walking across the fields to Stepney. In short, Whitechapel was a residential suburb of the commercial classes and not a place of poor natives and poorer aliens. There is little doubt that our crania even under the hypothesis that they belong to a clearance pit from Sheen's ground would be in bulk English and well-to-do. But is this hypothesis to be accepted? Sheen's ground does not appear to have been long in existence—possibly 1820 to 1854. There is no evidence of its ever having crossed the alley referred to above, and there is no reason to doubt the statement that the bones were exhumed from under houses built in (or before?) 1820. Lastly a most extensive system of almost immediate disinterment must have been carried on to allow of several hundred bodies being found placed as these were. It has been necessary, however, to refer to this matter because in the future someone might have been struck by the proximity of Sheen's ground to the site where our crania were excavated, and considered that this possibility had been overlooked. The fact, however, that Kinloch's Stores coincide with the position of a small enclosure in the maps of 1688 to 1720 seems to suggest that either this enclosure was itself a burial-ground or had been used as a pest-field. In either case we should date our skulls as a 17th century series. The existence of a negress' skull among them is not incompatible with this view, and they would then be fairly typical of the London English of that period. They agree very well on the whole with our second series from Moorfields, but neither seems sufficiently modern to belong to the 19th century; they differ in some respects sensibly from the modern English head.

### (4) *Measurements made, and Methods of Measurement.*

The measurements and nomenclature are those of the *Frankfurter Verständigung*, with certain exceptions which will be mentioned below.

I used the craniophor*, scriber, goniometer and blocks with which C. D. Fawcett worked, and which are fully described and illustrated in her paper†. The front block, however, was altered by having a projecting edge of 10 mm. length attached to its front; by this device the *gerade Länge* was always measured from the glabella, as the block was kept clear of the superciliary ridges, and the only part of it in contact with the skull was the projecting edge. Of course 10 mm. were always deducted from the reading on the scale showing the distance between the bases of the blocks.

In addition to these instruments I used callipers with curved arms, like those which Flower figures on page xvi. of his Catalogue, also large and small callipers with straight arms, and a steel tape.

* It would be an improvement I think if the craniophor were made larger and heavier, so as to have greater stability, and if the pointed clamping rod, by means of a spring or otherwise, could be kept always in contact with the skull; much time was lost in the simple operation of fixing the skull in the horizontal plane, owing to the rod losing its grip and falling down.

† *Biometrika*, Vol. I. pp. 413—415.

The three points by which the horizontal plane was determined were the highest points of the rims of the auricular passages and the under rim of the right eye socket, but in a very few cases, where the right eye was not available, the left eye socket was used.

The various measurements and the methods of making them were fully defined and explained by C. D. Fawcett*, so that I need only describe them very briefly here; but it is necessary to mention certain points more fully where my procedure differed from hers. I follow the order of her paper.

(*a*) Capacity. My method of measurement is described in the next section.

(*b*) Flower's ophryo-occipital length (*F*).

(*c*) Greatest length from glabella to occiput (*L*).

(*d*) Horizontal length, measured with the blocks, on the craniophor as described above (*L'*).

(*e*) Greatest horizontal breadth of skull (*B*).

(*f*) Least breadth of forehead, from one temporal crest to the other, across the frontal bone (*B'*).

(*g*) Height of skull. My attempts to measure the height in the way recommended by the *Frankfurter Verständigung* never seemed to me satisfactory, and I therefore adopted the method of Broca and the French school, taking the height as the distance from basion to bregma, which is the *Frankfurter Hilfs-Höhe.* Flower and Turner both agree with Broca in measuring their height from basion to bregma (*H*).

(*h*) Auricular height, the vertical height measured on the craniophor perpendicular to the horizontal plane in a line perpendicular to the auricular axis, with the vertical scale and sliding rod of the craniophor (*OH*).

In many skulls, owing to the auricular passages or to the orbits being damaged or destroyed, the horizontal plane, and consequently the auricular height, could not be determined. A "Hilfs-Ohrhöhe," however, was obtained in such cases where one or both auricular passages existed, by putting the skull on the craniophor, bringing the sliding rod down on the skull at a point 2—3 cms. behind the bregma, and reading off the height on the vertical scale. Where both auricular passages existed, I had only to read off the height; but where only one passage remained, the skull was supported on the defective side in what was judged to be a horizontal position before the sliding rod was brought down. Such "Hilfs-Ohrhöhen" are marked (*h*) in the Tables of measurements.

(*i*) Length of skull base, from basion to nasion (*LB*).

(*j*) Horizontal circumference, measured directly above the superciliary ridges and round the most projecting part of the occiput (*U*).

* *Loc. cit.*, pp. 416—418.

(*k*) Sagittal circumference or rather arc, from nasion over the top of the head to opisthion (*S*).

(*l*) Cross circumference or transverse arc, from the upper rim of one auricular passage to that of the other, over the bregma (*Q*).

The *Verständigung* measures it in a plane perpendicular to the horizontal plane, about 2—3 cm. behind the coronal suture, or, as Dr E. Schmidt* more accurately defines it, cutting the sagittal suture $2\frac{1}{2}$ cm. behind the bregma; Virchow†, however, appears to have taken the measurement over the bregma, and Turner‡ does the same.

(*m*) Face height. This measurement could not be taken, as no skulls were preserved with mandibles attached.

(*n*) Upper face height, from nasion to alveolar point ($G'H$).

(*o*) Face breadth, from the lower end of one zygomatic maxillary suture to that of the other ($GB$).

(*p*) Zygomatic breadth, from the outermost point of one zygomatic arch to that of the other ($J$).

(*q*) Nasal height, from middle of nasion to lowest edge of the pyriform aperture. The lowest edge was sometimes on the right side, sometimes on the left ($NH$).

(*r*) Nasal breadth—greatest breadth of the pyriform aperture ($NB$).

(*s*) Breadth of orbit ($O_1$) for the left ($L$) and right ($R$) eyes; the greatest breadth from side to side, wherever found, measuring from inner margin to inner margin.

In taking this measurement, the great difficulty is to determine on what point the arm of the callipers should be placed on the nasal side of the orbit§. I have followed what C. D. Fawcett calls the "geodesic" method, which in practice amounts to this: I follow the curvature of the lower orbital rim to its furthest inward point—but never cross the naso-frontal suture—and measure from that point. I found it convenient to mark the point determined upon with a pencil.

(*t*) Greatest height of orbit ($O_2$), for both eyes, taken perpendicular to $O_1$.

(*u*) Length of palate ($G_1$), from the point of the *spina nasalis posterior* to an imaginary surface tangential to the inner alveolar surfaces of the middle incisors‖.

I have also measured this length from the *base* of the spine to the same imaginary surface ($G_1'$).

* *Anthropologische Methoden*, p. 224.

† See note to paragraph 16 of the *Verständigung*.

‡ "Challenger" Report, Zoology, Part 29, 1884.

§ For a discussion of this difficulty see C. D. Fawcett, *loc. cit.*, pp. 430—431.

‖ See C. D. Fawcett's remarks on various ways in which this troublesome measurement has been taken, *loc. cit.*, pp. 429—430.

(*v*) Breadth of palate ($G_2$), between the alveolar walls at the second molars. Owing to great unevenness of the alveolar walls, I have frequently found this a difficult and unsatisfactory measurement.

(*w*) Profile length, from the basion to the alveolar point ($GL$).

No skull was found with mandible attached; the mandibles could not therefore be appropriated to their respective crania, nor have they been sexed. All the mandible measurements were kindly taken for me by Marion Radford.

(*x*) Condylar width, greatest width of mandible at condyles, from outside to outside ($W_1$).

(*y*) Angle width, greatest width of mandible at angles, from outside to outside ($W_2$).

(*z*) Greatest height of mandible, from lowest median projection, to top of process between middle incisors ($h_1$).

(*z'*) Distance between *foramina mentalia* ($f$).

It is unnecessary to specify here the various Indices given in the Tables, as the headings of their respective columns show what they represent. They have been found from the very useful *Index-Tabellen zum anthropometrischen Gebrauche* of Carl M. Fürst (Jena, Verlag von Gustav Fischer, 1902).

There remain only the angles to refer to.

(*aa*) Profile angle ($P$), measured with the goniometer. The skull is placed on the craniophor, and fixed in the position required for determining the horizontal plane, as explained above; the point of the upper bar of the goniometer is then brought into contact with the nasion, and the point of the lower bar with the alveolar point; the moveable rod of the goniometer is then brought parallel to the line joining the points of the bars by an easy adjustment, and the profile angle read off on the protractor scale.

The angles of the triangle formed by the profile length ($GL$), the skull basis ($LB$) and the upper face height ($G'H$), were kindly measured for me by Mary Beeton by placing the sides on the trigonometer made for Professor Pearson by the Cambridge Instrument Company*.

(*bb*) Alveolar angle ($A\angle$), between the lines $GL$ and $G'H$.

(*cc*) Nasial angle ($N\angle$), between $G'H$ and $LB$.

(*dd*) Basilar angle ($B\angle$), between $LB$ and $GL$.

(*ee*) Basio-nasal horizontal angle ($\theta_1 = 180° - N\angle - P\angle$).

(*ff*) Basio-alveolar horizontal angle ($\theta_2 = P\angle - A\angle$).

Like C. D. Fawcett, I attach most importance to $A\angle$, $N\angle$, and $B\angle$, owing to the difficulty of ascertaining $P\angle$ and the two subsidiary angles $\theta_1$ and $\theta_2$, which depend on $P$, to a satisfactory degree of accuracy.

* See C. D. Fawcett, *loc. cit.*, p. 418.

### (5) *On the Determination of the Capacity.*

In determining the capacity of the skulls, I used very hard, dry mustard seed, and my procedure was as follows. Through a tin funnel placed in the foramen magnum, I poured in a quantity of seed enough to fill the cavity about half-full, and then gave it a vigorous shaking, so as to get the seed well into the frontal part of the skull; I then filled up the cavity with more seed, to the rim of the foramen magnum, and shook and tapped; the seed of course flowed away in all directions, and I proceeded to fill up, and shake and tap again. This process went on until I was satisfied that I could get practically no more seed into the skull, but one of the greatest difficulties in the operation was to decide when this point was reached: often, when the skull seemed quite full, a turn of the hand would cause the seed to slip away into some unsuspected empty nook, leaving a vacant space round the foramen magnum. Indeed, in some of the skulls, I doubt if I ever succeeded in quite filling the cerebellar fossae.

The filling process being finished, the seed was poured from the skull into a tin can, and from thence through a funnel into the measuring glasses. I had to use more than one of these, as the largest had a capacity of only 1000 cm.$^3$. The process of shaking and tapping then went on with the glasses as with the skulls, until the subsidence of the seed appeared to come to an end, and the volume was then read off on the scale.

In this way I dealt with the first 31 skulls of the series which were sufficiently well preserved to admit of their capacity being determined, but obviously the process was tedious, as two measuring glasses had to be shaken and tapped for each skull, and it seemed doubtful whether I could obtain a fairly uniform density of seed in the glass measures in a series of operations extending over several weeks. Another doubt also suggested itself—was the density of seed in the skull the same as the density in the glasses?

It then occurred to me to weigh, instead of measuring, the seed contents of each skull, and then reduce the weights to volumes, having ascertained once for all the weight of a known volume of the seed. Accordingly I procured a good balance, capable of weighing up to 1500 grammes, and a copper vessel, with a counterpoise, for holding the seed. The skulls having been filled in the way described above, the contents were emptied into the copper vessel, which was then placed on the scale-pan, and the weight determined.

The relation between weight and volume had next to be found. The obvious course was to find a skull of known capacity, fill it with seed in the same manner as the Whitechapel skulls had been filled, and then weigh the contents. Professor Thane kindly placed at my disposal three "crânes étalons" which had been specially prepared, some years before, for having their capacity measured. They had been sawn horizontally into two pieces, and the inner surface painted with a thin coating of waterproof varnish; the two pieces had then been cemented together again, and the whole made watertight. I filled

these skulls several times with seed, through the foramen magnum, and weighed the contents, following the same procedure as in the case of the Whitechapel series; I also filled each of the three skulls with water of known volume, the filling being done twice. Knowing the volume of the water and the weight of the seed, I expected to find a fairly constant relation between the two in the various experiments. The results are exhibited in the following Table:

*Capacity of "Crânes Étalons."*

| Skull α | | Skull γ | | Skull δ | |
|---|---|---|---|---|---|
| cm.³ of water | Grammes of seed | cm.³ of water | Grammes of seed | cm.³ of water | Grammes of seed |
| 1445* | 1130·58 | 1790 | 1364·97 | 1375 | 1052·07 |
| 1465 | 1123·70 | 1790 | 1381·31 | 1385 | 1058·83 |
| | 1127·21 | | 1365·47 | | 1048·44 |
| | | | | | 1061·43 |
| Mean 1455 | 1127·16 | 1790 | 1370·58 | 1380 | 1055·19 |
| Weight of 1000 cm.³ seed | 774·68 | | 765·69 | | 764·63 |

This table brings out the difficulties of the investigation very forcibly. In the first place it will be noticed that, even using water, I failed to get quite uniform results for the capacity of skull α; an air-bubble may have formed in the recesses of the skull in the first experiment, or a slight leak may have developed in the second, or I may have made some mistake in filling or in noting the volume of water. Again, greater density of seed, on the average, was produced in skull α than in γ and δ; and in the two latter, although the average density was nearly the same, the density was not uniform in the various experiments, the difference between maximum and minimum weight of seed in each of the skulls being about 1¼ per cent. But, considering the diversity in the shape of the skulls, and the particularly long time required to fill them, I am not surprised at this want of uniformity in density.

The average of the experiments on the three "crânes étalons" brings out the weight of 1000 cm.³ of the seed at 768·33 grammes, and I have adopted this as the constant relation between weight and volume. To reduce the weights to volumes, I have therefore multiplied the former by $\frac{1000}{768{\cdot}33}$, say 1·302, and taken the result to the nearest 5 cm.³.

In order to form an idea of the relation between volume and weight of seed when packed in the measuring glasses, I filled the 1000 cm.³ glass ten times with the seed, shaking and tapping to about the same degree as I had done before when measuring the first 31 skulls, and then weighed the seed on the balance.

* I make this skull 1445 cm.³ and obtain almost exactly 767 grs. from its weight of mustard seed. K. P.

The weights, in the order in which they were taken, were 766·10, 766·80, 764·22, 763·15, 768·95, 769·75, 766·70, 760·60, 764·25, and 764·30 grammes, the average being 765·48, and the difference between maximum and minimum weight being about 1¼ per cent. This average, it will be observed, agrees pretty closely with the average obtained from the "crânes étalons," but as it shows that the density of seed in the glass was somewhat less, say a half per cent. less, than that in the skulls, some correction should be made in the capacities which I recorded of the 31 skulls first measured. I have, as a matter of fact, reduced them one per cent., because I feel confident that, when working on these skulls, I subjected the measuring glass to a less thorough process of shaking and tapping than later on, when I came to make the ten experiments just described*.

In order to ascertain whether the state of the weather affected the weight of the seed, I put aside a quantity weighing about 756 grammes, and weighed it on six different days in January last year; two of the days were bright and dry, the others damp and cloudy. The variation in weight was less than half a gramme, and may therefore be considered negligible.

I may add that the process of determining the capacity, whether by the glass measure or the balance, was very slow; I never succeeded in taking more than three capacities in an hour.

I am fortunately able to compare the result of my method and my personal equation with those of some of the other workers at University College. Some four or five years ago G. U. Yule measured 48 of the same crania. These crania give the following results:

| | *Yule* | *Macdonell* |
|---|---|---|
| 21 ♂s | 1531 | 1543 |
| 27 ♂s | 1321 | 1329 |

In the averages of 21 and 27 cases our differences were 12 and 8 cm.³ respectively. Our average differences in reading were 20 cm.³ in the first and 18 cm.³ in the second series. I have also the measurements of 11 skulls made by A. Martin Leake. His mean value for the eleven was 1389 as against my 1400, and our average difference was 11 cm.³. His average difference from G. U. Yule on these skulls was 8·6 cm.³, and the latter made the mean 1385. Yule

* It is perhaps worth while pointing out that different results are obtained according as the vessel is filled full or only partly filled with seed, before the tapping and shaking process begins. For instance, I made the following experiments with a 1000 cm.³ glass measure, 64 mm. in diameter:

(1) The vessel was filled with seed, without shaking or tapping, and then tapped and shaken; when subsidence had apparently ceased, it was again filled up, and the packing went on again until it was finally filled up. The contents were found to weigh 759·60 grammes.

(2) The packing process began when the vessel was three-fourths filled; after subsidence it was filled up, then tapped again, and finally filled up with tapping. Weight of contents 775·62 grammes.

(3) The vessel was two-thirds filled without shaking or tapping and then tapped; filled to about seven-eighths full and tapped; finally filled up. Weight of contents 776·98 grammes.

(4) Similar to (3), the stages being one-third full, one-half full, and full. Weight of contents 778·52 grammes.

and Leake were working with mustard seed and using Flower's method. These results confirm the view that different observers using the same method may have an average difference of 10 cm.$^3$, and if they use different methods an average difference of even 20 cm.$^3$. On the other hand, with careful treatment, different measurers working with different methods will hardly differ in the averages of fairly long series by more than 10 to 15 cm.$^3$. I think we must be content with this degree of agreement at the present stage. My method of weighing after single packing is sensibly shorter than that of double packing, and it appears to give results in substantial agreement with the latter.

### (6) *On the degree of Homogeneity possessed by the present Series of English Skulls.*

Considering the history of the ground where the skulls were discovered, as set forth in section (3) above, we may conclude that our material is fairly homogeneous without further inquiry, but it may be well to compare their variability in length and breadth with that of other long and probably homogeneous series.

*Variability of other Series.*

(Standard Deviations and Coefficients of Variation.)

| Series | $L\,\delta$ | | $L\,♀$ | | $B\,\delta$ | | $B\,♀$ | |
|---|---|---|---|---|---|---|---|---|
| | S. D. | C. of V. | S. D. | C. of V. | S. D. | C. of V. | S. D. | C. of V. |
| Naqada* ... ... | 5·72 | 3·09 | 5·25 | 2·96 | 4·61 | 3·42 | 4·09 | 3·42 |
| Bavarian† ... ... | 6·09 | 3·37 | 6·20 | 3·57 | 5·85 | 3·89 | 4·89 | 3·39 |
| Aino† ... ... | 5·94 | 3·19 | 5·45 | 3·08 | 3·90 | 2·76 | 3·66 | 2·67 |
| Parisians‡ ... ... | 5·94 | — | — | — | 5·21 | — | — | — |
| Whitechapel English... | 6·27§ | 3·31 | 6·22 | 3·45 | 5·28§ | 3·75 | 4·77 | 3·54 |
| Heterogeneous Scottish | 7·42 | 3·97 | 7·15 | 4·00 | 5·96 | 4·13 | 5·11 | 3·71 |

Seeing how closely our series agrees in variability for both sexes, with the homogeneous Altbayerisch crania of Professor Ranke, the conclusion that we are dealing with reasonably homogeneous material seems justified. The individual crania have also what may be described as a strong family likeness, the only widely divergent skull in the series excluded from my data was apparently that of a negro. Their mean characters agree quite closely with those of another fairly long series of English skulls, which I shall deal with in a later memoir. Their great length and dolichocephaly effectively differentiate them from any German, French

* C. D. Fawcett, *Biometrika*, Vol. I. p. 424.

† Alice Lee, *Phil. Trans.* Vol. 196, A, p. 230.

‡ *Biometrika*, Vol. II. p. 346.

§ For an explanation of the difference between these results and those published in *Biometrika*, Vol. II. p. 346, see p. 191 above.

or Jewish population, which might be supposed to have existed in Whitechapel*. No series of continental crania appears to have comparable characters. Judging solely by appearance and range of abnormality—in default of any published measurements—Professor Pearson suggests that the present series and in a still more marked manner the second series referred to above are closer to the Long Barrow British than to the Round Barrow British, Romano-British, Anglo-Saxon, or the "mediaeval English" which are represented in our museums. The fact that the Whitechapel series is not unique, but repeats itself in a rather intensified form in crania from another London district, seems to indicate that we are not dealing with an isolated group, but with the typical skull of the citizen of London a century or two ago. If this view be correct, there is an individuality about the London, if not the English skull which may serve to modify considerably opinions formed from the isolated, and often stringently selected "English" skulls to be found in museums and anatomical collections†. The view here suggested will, perhaps, be partially indicated by the skulls figured in our plates; it will be still more manifest in the illustrations which will accompany the account of the second or Moorfields series.

### (7) *Mean Values of the Characters of the present Series, and their Comparison with those of allied and other Races.*

Tables I. and II. give the mean values of the principal characters, the probable errors of the means, and the number of skulls dealt with.

For purposes of comparison I give the data for several allied races:

(*a*) Ranke's measurements on Altbayerisch skulls from his *Beiträge zur physischen Anthropologie der Bayern*, Bd. I. The means are taken from C. D. Fawcett's Naqada Memoir.

(*b*) Würtemberg crania, from *Die anthropologischen Sammlungen Deutschlands*, XVI., *Tübingen.*

(*c*) French soldiers who died in Munich during the Franco-Prussian war—56 crania, some rather juvenile—measurements from *Die anthropologischen Sammlungen Deutschlands* X., *München.*

I owe the calculation of the means of (*b*) and (*c*) to the kindness of Dr Alice Lee.

I also add the data for one unallied race, the Naqada, which of course I owe to C. D. Fawcett.

* As we have already indicated, Whitechapel even later than the beginning of the 19th century did not contain a mixed population of "aliens." It was a suburban district close to open fields with a fairly well-to-do resident commercial population. The riverside and rougher population was farther south, at Wapping. In 1707 fields separated Whitechapel from Wapping, and the London Docks were "Garden Grounds." The "Commercial Road" did not exist, and as late as 1806, when it did exist, fields run north and south of it in all directions.

† It is perhaps deserving of record that a German craniologist, who happened to see our second series, without a hint on our part could find nothing comparable to them but "Reihengräber Schädeln."

## TABLE I.

*Comparison of English Cranial Means with those of other Races.*

MALE.

| Character and Reference Letter | English and Allied Races | | | | | | | Unallied Race | |
|---|---|---|---|---|---|---|---|---|---|
| | English | | Altbayerisch (Modern German) | | Würtemberger (Modern German) | | 56 French Soldiers | Naqadas | |
| | No. | Mean | No. | Mean | No. | Mean | Mean | No. | Mean |
| (*a*) *C* ... ... | *72* | 1476·94 ± 9·73 | *100* | 1503·5 | *91* | 1493·77 | 1473 | *88* | 1381·0 |
| (*b*) *F* ... ... | *138* | 187·35 ± ·35 | — | — | — | — | — | *121* | 183·96 |
| (*c*) *L* ... ... | *137* | 189·06 ± ·36 | *100* | 180·58 | *97* | 179·48 | 179·96 | *139* | 185·13 |
| (*d*) *L′* ... ... | *72* | 187·76 ± ·45 | — | — | *95* | 177·96 | — | *121* | 184·87 |
| (*e*) *B* ... ... | *135* | 140·67 ± ·31 | *100* | 150·47 | *96* | 147·88 | 143·41 | *139* | 134·87 |
| (*f*) *B′* ... ... | *132* | 98·02 ± ·25 | *72* | 103·70 | *98* | 97·19 | 96·21 | *140* | 91·06 |
| (*g*) *H* ... ... | *122* | 132·04 ± ·34 | *99* | 133·78 | *93* | 130·94 | 130·68 | *134* | 135·21 |
| (*h*) *OH* ... | *135* | 114·59 ± ·25 | *100* | 120·75 | *94* | 115 | 112·86 | *140* | 115·59 |
| (*i*) *LB* ... | *119* | 101·60 ± ·25 | *85* | 100·30 | *96* | 98·60 | 99·70 | *109* | 99·34 |
| (*j*) *U* ... ... | *131* | 524·25 ± ·88 | *99* | 524·35 | *96* | 517·82 | 518·20 | *118* | 511·02 |
| (*k*) *S* ... ... | *131* | 377·11 ± ·81 | *80* | 365·10 | *93* | 367·20 | 365·96 | *119* | 373·02 |
| (*l*) *Q* ... ... | *115* | 307·93 ± ·72 | *87* | 329·70 | *95* | 323·97 | 312·20 | *116* | 304·22 |
| (*n*) *G′H* ... | *75* | 70·17 ± ·30 | *56* | 70·80 | *76* | 71·46 | 68·39 | *85* | 67·59 |
| (*o*) *GB* ... | *55* | 90·87 ± ·45 | *49* | 95·10 | *94* | 92·46 | 92·46 | *82* | 95·85 |
| (*p*) *J* ... ... | *43* | 130·05 ± ·57 | *56* | 135·00 | *94* | 133·33 | 130·70 | *53* | 125·63 |
| (*q*) *NH* ... | *79* | 51·22 ± ·20 | *70* | 50·90 | *94* | 51·45 | 51·23 | *91* | 48·94 |
| (*r*) *NB* ... | *70* | 24·29 ± ·17 | *70* | 24·80 | *95* | 23·91 | 23·13 | *86* | 25·12 |
| (*s*) $O_1L$ ... | *63* | 43·06 ± ·15 | *71** | 39·90 | *96** | 39·78 | 38·21* | *82* | 43·11 |
| (*s′*) $O_1R$ ... | *68* | 42·99 ± ·16 | | | | | | *81* | 42·60 |
| (*t*) $O_2L$ ... | *67* | 33·46 ± ·15 | *71** | 33·72 | *96** | 34·10 | 33·32* | *80* | 32·67 |
| (*t′*) $O_2R$ ... | *69* | 33·42 ± ·18 | | | | | | *72* | 31·87 |
| (*u*) $G_1$ ... | *69* | 48·27 ± ·22 | *56* | 44·30 | *75* | 51·68 | 46·57 | *75* | 55·80 |
| (*v*) $G_2$ ... | *66* | 36·78 ± ·24 | *53* | 33·20 | *73* | 38·12 | 37·20 | *75* | 40·33 |
| (*u′*) $G_1'$ ... | *69* | 44·66 ± ·21 | — | — | — | — | — | — | — |
| (*w*) *G′L* ... | *73* | 95·93 ± ·35 | — | — | — | — | — | *81* | 94·72 |
| (*aa*) *P*∠ ... | *63* | 86°·09 ± ·33 | *40* | 89°·10 | *77* | 86°·42 | 86°·46 | *62* | 84°·41 |
| (*bb*) *A*∠ ... | *69* | 73°·38 ± ·28 | — | — | — | — | — | *73* | 72°·82 |
| (*cc*) *N*∠ ... | *69* | 65°·19 ± ·29 | — | — | — | — | — | *73* | 66°·60 |
| (*dd*) *B*∠ ... | *69* | 41°·43 ± ·20 | — | — | — | — | — | *73* | 40°·73 |
| (*ee*) $\theta_1$ ... ... | *59* | 28°·71 ± ·22 | — | — | — | — | — | *62* | 28°·29 |
| (*ff*) $\theta_2$ ... ... | *59* | 12°·92 ± ·29 | — | — | — | — | — | *62* | 11°·30 |
| (*α*) $100B/L'$ ... | *69* | 75·17 ± ·24 | — | — | — | — | — | *101* | 72·70 |
| (*β*) $100B/L$ ... | *131* | 74·34 ± ·19 | *100* | 83·20 | *96* | 82·45 | 79·79 | *130* | 72·99 |
| (*γ*) $100H/L'$ ... | *69* | 70·40 ± ·22 | — | — | — | — | — | *98* | 73·20 |
| (*δ*) $100H/L$ ... | *120* | 69·97 ± ·20 | *99* | 74·20 | *93* | 73·02 | 72·57 | *131* | 73·30 |
| (*ε*) $100H/B$ ... | *116* | 94·31 ± ·29 | *99* | 89·10 | *92* | 88·50 | — | *131* | 100·47 |
| (*ζ*) $100B/H$ ... | *116* | 106·26 ± ·32 | — | — | — | — | 109·65 | *131* | 99·76 |
| (*θ*) $100G'H/GB$ | *53* | 76·52 ± ·50 | *48* | 74·50 | *74* | 78·10 | 74·19 | *76* | 70·63 |
| (*κ*) $100NB/NH$ | *70* | 47·55 ± ·37 | *70* | 48·70 | *93* | 46·59 | 45·26 | *77* | 51·08 |
| (*λ*) $100O_2/O_1$, *L* | *63* | 77·86 ± ·32 | *71** | 84·5 | *96** | 85·85 | 87·27* | *77* | 74·89 |
| (*λ′*) $100O_2/O_1$, *R* | *68* | 77·69 ± ·38 | | | | | | *76* | 74·87 |
| (*μ*) $100G_2/G_1$ ... | *61* | 76·26 ± ·55 | *47* | 74·4 | *66* | 74·21 | 80·14* | *67* | 71·94 |

* Only one eye taken, and which not stated.

## TABLE II.

*Comparison of English Cranial Means with those of other Races.*

FEMALE.

| Character and Reference Letter | English and Allied Races | | | | | | Unallied Race | |
|---|---|---|---|---|---|---|---|---|
| | English | | Altbayerisch (Modern German) | | Würtemberger (Modern German) | | Naqadas | |
| | No. | Mean | No. | Mean | No. | Mean | No. | Mean |
| (*a*) *C* ... ... | *80* | 1299·87 ± 8·51 | *100* | 1335·50 | *18* | 1336·83 | *123* | 1287·9 |
| (*b*) *F* ... ... | *143* | 180·14 ± ·36 | — | — | — | — | *168* | 177·41 |
| (*c*) *L* ... ... | *140* | 180·36 ± ·35 | — | 173·45 | *19* | 172·74 | *185* | 177·47 |
| (*d*) *L'* ... ... | *57* | 180·07 ± ·57 | — | — | *19* | 171·90 | *159* | 177·89 |
| (*e*) *B* ... ... | *140* | 134·68 ± ·27 | *100* | 143·98 | *19* | 142·90 | *185* | 131·50 |
| (*f*) *B'* ... ... | *147* | 93·12 ± ·23 | *83* | 96·30 | *19* | 93·90 | *181* | 88·23 |
| (*g*) *H* ... ... | *124* | 124·56 ± ·30 | *96* | 128·01 | *19* | 126·26 | *169* | 129·47 |
| (*h*) *OH* ... ... | *143* | 109·21 ± ·25 | *100* | 114·17 | *19* | 112·68 | *174* | 113·11 |
| (*i*) *LB* ... ... | *122* | 95·34 ± ·24 | *90* | 95·80 | *19* | 93·63 | *141* | 94·86 |
| (*j*) *U* ... ... | *136* | 503·84 ± ·85 | *99* | 501·40 | *19* | 500·58 | *146* | 493·74 |
| (*k*) *S* ... ... | *130* | 362·76 ± ·84 | *90* | 353·40 | *19* | 358·16 | *151* | 363·64 |
| (*l*) *Q* ... ... | *122* | 293·97 ± ·71 | *97* | 318·70 | *18* | 314·95 | *151* | 296·49 |
| (*n*) *G'H* ... | *62* | 65·93 ± ·40 | *66* | 66·80 | *15* | 65·80 | *119* | 65·84 |
| (*o*) *GB* ... ... | *58* | 84·86 ± ·41 | *66* | 89·70 | *19* | 88·50 | *113* | 92·51 |
| (*p*) *J* ... ... | *33* | 120·27 ± ·58 | *67* | 126·30 | *18* | 124·44 | *63* | 117·04 |
| (*q*) *NH* ... | *67* | 48·68 ± ·22 | *72* | 48·20 | *19* | 45·74 | *123* | 46·73 |
| (*r*) *NB* ... ... | *64* | 23·19 ± ·14 | *72* | 23·70 | *19* | 23·05 | *119* | 24·31 |
| (*s*) $O_1L$ ... | *57* | 41·17 ± ·13 | *79** | 38·32 | *19** | 37·95 | *118* | 41·70 |
| (*s'*) $O_1R$ ... | *62* | 40·95 ± ·14 | | | | | *113* | 41·30 |
| (*t*) $O_2L$ ... | *64* | 33·59 ± ·12 | *79** | 33·18 | *19** | 32·21 | *117* | 32·16 |
| (*t'*) $O_2R$ ... | *64* | 33·73 ± ·13 | | | | | *116* | 31·87 |
| (*u*) $G_1$ ... ... | *57* | 45·13 ± ·26 | *57* | 42·20 | *15* | 50·20 | *103* | 53·89 |
| (*v*) $G_2$ ... ... | *58* | 35·22 ± ·24 | *55* | 32·10 | *15* | 37·20 | *103* | 38·87 |
| (*u'*) $G_1'$ ... ... | *58* | 41·53 ± ·22 | — | — | — | — | — | — |
| (*w*) *GL* ... ... | *58* | 90·42 ± ·40 | — | — | — | — | *106* | 91·02 |
| (*aa*) *P*∠ ... ... | *52* | 87°·13 ± ·27 | *61* | 88°·8 | *14* | 84°·93 | *89* | 84°·49 |
| (*bb*) *A*∠ ... ... | *57* | 73°·90 ± ·29 | — | — | — | — | *93* | 72°·62 |
| (*cc*) *N*∠ ... ... | *57* | 64°·70 ± ·23 | — | — | — | — | *93* | 66°·40 |
| (*dd*) *B*∠ ... ... | *57* | 41°·39 ± ·27 | — | — | — | — | *93* | 40°·98 |
| (*ee*) $\theta_1$ ... ... | *50* | 28°·11 ± ·24 | — | — | — | — | *89* | 29°·09 |
| (*ff*) $\theta_2$ ... ... | *50* | 13°·13 ± ·34 | — | — | — | — | *89* | 11°·82 |
| (*a*) $100B/L'$ ... | *55* | 74·62 ± ·27 | — | — | — | — | *146* | 73·86 |
| (*β*) $100B/L$ ... | *130* | 74·73 ± ·18 | *100* | 83·10 | *19* | 82·78 | *169* | 74·19 |
| (*γ*) $100H/L'$ ... | *55* | 69·05 ± ·26 | — | — | — | — | *141* | 73·11 |
| (*δ*) $100H/L$ ... | *117* | 69·13 ± ·18 | *96* | 73·90 | *19* | 73·17 | *166* | 73·22 |
| (*ε*) $100H/B$ ... | *115* | 92·35 ± ·24 | *96* | 88·80 | *15* | 88·46 | *169* | 98·66 |
| (*ζ*) $100B/H$ ... | *115* | 108·46 ± ·28 | — | — | — | — | *163* | 101·59 |
| (*θ*) $100G'H/GB$ | *54* | 77·94 ± ·57 | *58* | 74·40 | *15* | 74·11 | *106* | 70·36 |
| (*κ*) $100NB/NH$ | *64* | 47·79 ± ·33 | *72* | 49·20 | *19* | 50·33 | *113* | 52·31 |
| (*λ*) $100O_2/O_1$, *L* | *57* | 81·70 ± ·38 | *79** | 86·60 | *19** | 85·11 | *111* | 76·91 |
| (*λ'*) $100O_2/O_1$, *R* | *62* | 82·46 ± ·37 | | | | | *113* | 77·32 |
| (*μ*) $100G_2/G_1$ | *51* | 77·69 ± ·62 | *51* | 76·00 | *14* | 74·59 | *97* | 72·30 |

* Only one eye taken, and which not stated.

Dealing first with male skulls, I will compare our series with modern English and allied races as regards capacity, head length, head breadth and cephalic index. The measurements of $L$ and $B$ on the living head are reduced by 11 mm., the estimated thickness of the covering tissues, and the capacity of the modern English is deduced from A. Lee's formula, *Phil. Trans.*, Vol. 196, A, p. 252.

TABLE III.

*Male Crania.*

| | $C$ | $L$ | $B$ | $B/L$ |
|---|---|---|---|---|
| Whitechapel English, 1st series ... | 1477 | 189·1 | 140·7 | 74·3 |
| Moorfields English, 2nd series* ... | 1473 | 189 | 143·1 | 75·7 |
| Modern English, 1000 upper class† ... | [1431 ?] | 182·5 | 143 | 78·3 |
| „ „ 3000 criminals† ... | [1378 ?] | 180·7 | 139·4 | 77·2 |
| British Association† ... ... ... | [1495] | 187·1 | 144·0 | 77·0 |
| Altbayerisch ... ... ... ... | 1503 | 180·6 | 150·5 | 83·2 |
| Würtemberger ... ... ... ... | 1494 | 179·5 | 147·9 | 82·4 |
| French soldiers ... ... ... ... | 1473 | 180 | 143·4 | 79·8 |

From these figures it appears that a marked change has been going on in the shape of English skulls during the last two or three centuries; the length has been decreasing and the breadth increasing, leading to a more brachycephalic type. This change is even more marked when we compare English with modern Germans, and it is interesting to note that C. D. Fawcett was able to show from a comparison of Naqadas with Thebans and Copts that a change in the same direction has taken place in the development of Egyptian skulls‡.

In frontal breadth, height of skull and auricular height, English agree very closely with modern Würtembergers but are inferior to the Altbayerisch. Further, in modern Germans the face breadth and zygomatic breadth are greater than in our series, while length of skull base, upper face height, nose and height of orbit are very much the same in both.

The comparatively small breadth of eye orbit in the modern races is noteworthy, and suggests that the measurement on the nasal side had been taken from the dacryon, so that comparison with our series is impossible.

The palate measurements of Altbayerisch and Würtemberger differ extremely, but it is to be observed that if we assume that the latter were measured in accordance with the Frankfurt Concordat, and we deduct 4—5 mm. from the length in order to make it comparable with ours§ (the Concordat length being measured

* From unpublished measurements on a second series of skulls at University College, which will form the subject of another paper in *Biometrika* at an early date.

† *Biometrika*, Vol. I. pp. 181, 188, 189. These are reconstructed from Dr Lee's formulae. The absence of head height in the Cambridge students and the criminals renders the predicted skull capacity of small weight in these cases.

‡ *Biometrika*, Vol. I. p. 433.

§ *Biometrika*, Vol. I. p. 430.

up to the inner wall of the alveolar margin between the middle incisors, our length to a surface tangential to the inner alveolar surfaces of these incisors), we reduce the Würtemberger $G_1$ to 47·18. On the other hand, if we assume that the Altbayerisch were measured by Schmidt's convention, that is, in the same way as ours except that he measures from the *base* of the spina, we must add the length of the spina, say 3·6 (the difference between $G_1$ and $G_1'$ in our series), thus bringing the Altbayerisch $G_1$ up to 47·90. The English and modern German palate length would thus be brought into fairly close agreement, but I cannot reconcile the extraordinary differences in palate breadths, and yet it is difficult to suppose that the Altbayerisch and Würtemberger differ so remarkably in this character.

Having compared our series with allied races we will now proceed to compare them with a totally different race, the Naqadas. Dealing still with the males, we see that in length, breadth, and capacity the English skull is much the larger, but in basio-bregmatic and auricular height it is inferior to the Egyptian. The greater height of the Naqada skull is very marked, and this has the effect of bringing the English and Naqada sagittal and cross circumferences quite near each other. There is also a very marked difference between the two races in the *face*; the Naqada face is much broader, and the nose shorter and broader. Allowing for the method of measuring the breadth of the Naqada orbit*, we find that the Naqada *eye* was considerably smaller, both in height and breadth, and rounder, the orbital index calculated on the amended breadth of orbit being about 78·8 as against the English average 77·8. The great difference in *palate* length is partly due to the adoption of different systems of measurement; deducting 4·87 mm. from the Naqada mean†, in order to make it comparable with the English mean, we still find the Naqada palate considerably the longer, being 50·93 mm. as compared with the English 48·27: it is also very much the wider.

While differing in all other respects, there is a remarkable agreement between the English and Naqada skulls as regards the angles $\theta_1$ and $\theta_2$, and also the angles of the triangle formed by joining the nasion, basion, and alveolar point: that is, although the sides of this triangle are longer in the English skulls than in the Naqada, the included angles are nearly the same, or the triangles are nearly "similar" in the two races. I will return to this point further on.

Turning now to female skulls, I am not aware of any measurements of modern French female heads available for comparison with our series; the following table is therefore less complete than No. III.

We note as in the case of the males that the skull appears to be growing shorter. The breadth does not here appear to have sensibly increased, but greater capacity has been obtained by increased auricular height.

A comparison with modern Germans leads to results very similar to those which we found when comparing the males of the two races. The modern German skull is shorter and broader than the English; in frontal breadth, however, the

* *Biometrika*, Vol. I. p. 431.

† *Biometrika*, Vol. I. p. 430.

English agree very closely with the Würtembergers but in basio-bregmatic and auricular height are inferior to both German series, especially to the Altbayerisch, also in face breadth and zygomatic breadth they are markedly inferior. In length of skull base, upper face height, nose and height of orbit, our series and the Altbayerisch are very nearly alike; in these characters the Würtembergers are smaller than the other two, especially in height of nose.

TABLE IV.

*Female Crania.*

| | *C* | *L* | *B* | *B/L* |
|---|---|---|---|---|
| Whitechapel English, 1st series ... ... | 1300 | 180·4 | 134·7 | 74·7 |
| Moorfields „ 2nd series* ... | 1330 | 183·7 | 137·6 | 74·9 |
| Modern English, London Students† ... | [1356] | 178·7 | 135·8 | 75·8 |
| „ „ British Association ... | [1324] | 174·6 | 137·3 | 78·6 |
| Altbayerisch... ... ... ... ... | 1335 | 173·4 | 144 | 83·1 |
| Würtemberger ... ... ... ... | 1336 | 172·7 | 142·9 | 82·8 |

The eye measurements again suggest that the breadth was measured from the dacryon, and in the case of the palate we are again met by a very marked difference between Altbayerisch and Würtemberger. If we assume that the former were measured by Schmidt's convention, we shall have to add the length of the *spina*, which in our series is 3·6 (the difference between $G_1$ and $G_1'$), to the length given in the table; this would make the Altbayerisch $G_1 = 45{\cdot}80$. In the case of the Würtembergers, assuming that they were measured in accordance with the Frankfurt Concordat, we must make a deduction from the length to make it comparable with that of our series, say a deduction of 4 mm.‡, thus reducing $G_1$ to 46·20. In this way we should bring English and modern German palate lengths into close agreement, but in the absence of information as to the German methods of measurement the agreement is purely hypothetical, as in the case of the male crania.

The discordance in palate breadth between English, Altbayerisch, and Würtemberger is again very noticeable.

We will now compare our series with the Naqadas, with similar results to those which we found when comparing the male crania. The English skull is the larger in all the *lengths* except basio-bregmatic and auricular height; in both of these characters the Naqada skull is considerably loftier. The Naqada *face* was much broader, and the nose shorter and broader. The Naqada *orbit* also, when

* These are the crania referred to in the Note on p. 210, *supra*.

† A small series of Bedford College Students, to which probably not much weight must be attached. See A. Lee, *loc. cit.* p. 258. A modification has been made in the calculated capacity as it is probable that the auricular height is about 4 mm. too large.

‡ *Biometrika*, Vol. I. p. 430.

allowance is made for the method of measurement, is found to be smaller than the English, but, unlike the male, *less* round, and the palate was much longer and broader.

We will conclude our comparisons by referring to the triangle whose apices are the basion, nasion, and alveolar point; the sides of this triangle are very nearly equal in both races and the contained angles are therefore nearly equal; and further, we have this remarkable fact, that these angles closely approximate to the angles of the corresponding triangle for male crania, both English and Naqada. Whether or not we have a specific character in this triangle further research alone will show. It is greatly to be desired that measurements of it should be made on the long series of skulls possessed by many German museums.

As the mandibles are unsexed, they are given in a separate Table.

TABLE V.

*Comparison of Means of English Mandibles with those of the Naqada race.*

| Character and Reference Letter | English | | Naqada | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Male and Female | | Male | | Female | | Male and Female | |
| | No. | Mean | No. | Mean | No. | Mean | No. | Mean |
| ($x$) $W_1$ ... | *108* | 113·21 ± ·41 | *41* | 110·49 ± ·87 | *52* | 106·37 ± ·67 | *93* | 108·19 |
| ($y$) $W_2$ ... | *151* | 95·40 ± ·46 | *51* | 93·58 ± ·67 | *59* | 87·62 ± ·55 | *110* | 90·38 |
| ($z$) $h_1$ ... | *133* | 30·76 ± ·21 | *60* | 32·91 ± ·28 | *75* | 31·61 ± ·21 | *135* | 32·19 |
| ($z'$) $f$ ... | *170* | 43·67 ± ·14 | *49* | 44·44 ± ·25 | *60* | 43·12 ± ·20 | *109* | 43·71 |

The points to be noticed are: (1) the English skulls have greater condylar and angle widths, and (2) a smaller "maximum height" of mandible than the Naqadas; but (3) the distance between the *foramina mentalia* is nearly the same in both races.

Having dealt with the means, we turn to the *indices* of the English skulls, and giving them their classes according to the Frankfurt Concordat we can now compare the two sexes.

Here we find no marked difference between the two sexes except in the shape of the eye orbit, which is much rounder, and in the palate, which is less leptostaphyline in the female than in the male. In the Altbayerisch skulls also, there are no marked sexual differences except in eye orbit and palate, and in these characters the sexes differ in the same way as our English series. The Würtemberg skulls, however, differ both from English and Altbayerisch in this respect, that the chief differences between the sexes in this group are in upper face index and nasal index: the males have a much narrower face and much longer nose than the females.

The great general likeness between the sexes in English and modern Germans is in marked contrast to the sexual diversity that prevailed amongst the Naqadas.

TABLE VI.

*Specification of English Crania.*

| Character | Class ♂ | Class ♀ | Remarks |
|---|---|---|---|
| ($\beta$) $100B/L$ ... ... | Dolichocephaly | Dolichocephaly | Both sexes alike |
| ($\gamma$) $100H/L$ ... ... | Chamaecephaly | Chamaecephaly | Both sexes are on the borders of orthocephaly, the male rather more closely than the female |
| ($\alpha\alpha$) Profile Angle ... | Mesognathy | Mesognathy | The female tends rather more than the male to hyperorthognathy. |
| ($\theta$) Upper Face Index ... | Narrow faced | Narrow faced | The female is the narrower |
| Zygomatic „ „ *„ ... | Leptoprosopy | Leptoprosopy | ♂ index 53·77; ♀ index, 54·82† |
| ($\lambda$) Orbital Index‡ ... | Chamaeconchy | Mesoconchy | Left eye index practically the same as the right eye index in both sexes |
| ($\kappa$) Nasal Index ... ... | Mesorrhiny | Mesorrhiny | Both sexes alike, and not far from leptorrhiny |
| ($\mu$) Palate Index‡ ... | Leptostaphyline | Leptostaphyline | The female tends more to mesostaphyline |
| Alveolar Index* ... | 94·42 | 94·84 | Sexes practically alike§ |

*General Points.*

(*a*) The average male skull is significantly larger than the average female skull, except in the case of the breadth of the eye orbit, in regard to which the sexes are practically alike.

(*b*) In both sexes the breadth of the skull is significantly greater than the height, the excess being greatest in females.

(*c*) The left orbit is practically the same as the right orbit for both length and breadth in both sexes, and in the case of the breadth both sexes are practically alike. C. D. Fawcett found the left orbit to be larger than the right in the Naqadas, and has collected cases of asymmetry in other parts of the skeleton‖.

* These indices are simply the ratios of the means of the characters. The alveolar index 100 $GL/LB$ is not considered in the *Frankfurter Verständigung*. The zygomatic upper face index is 100 $G'H/J$.

† For Altbayerisch skulls this index is, for ♂ 52·4; for ♀ 52·8; for Würtemberger, ♂ 53·6, ♀ 52·9; for the small series of French soldiers 52·3.

‡ The methods of measurement which I have adopted have to be borne in mind; if I had measured by the Frankfurt Concordat both sexes would have shown chamaeconchy, but would have remained leptostaphyline.

§ For Naqadas this index is for ♂ 95·35; for ♀ 95·95.

‖ *Biometrika*, Vol. I. p. 436.

(*d*) My measurements confirm C. D. Fawcett's conclusion* that there is little advantage in measuring all three lengths, *F*, *L*, and *L'*; in the female skulls the difference between them is hardly appreciable, and the indices involving *L* and *L'* are almost identical. In the male skulls, the difference between *F* and *L'* is within the limits of random sampling; the difference between indices involving *L* and *L'*, however, is beyond these limits.

### (8) *Photographic Study of the English Skull*†.

The present photographic study of the English skull consists of two parts. The first deals with the normal skull, and the second with special skulls showing points of anatomical or pathological interest.

#### (*a*) *Normal Crania.*

In selecting normal crania, for reproduction, we have been guided by the desire to show not only "modal" individuals, but individuals at some distance from the mode on either side. Thus W. 45 ♂ is a typical English skull. We have for example:

| Character | *C* | *L* | *B* | *H* | *OH* | *U* | *S* | *Q* | *NH* | *NB* | *GL* | *B/L* | *H/L* | *NB/NH* | $O_2/O_1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean Male Skull | 1477 | 189 | 141 | 132 | 115 | 524 | 377 | 308 | 51 | 24 | 96 | 74 | 70 | 48 | 78 |
| W. 45 ... ... | 1495 | 190 | 141 | 136 | 114 | 521 | 382 | 307 | 53 | 24 | 96 | 74 | 72 | 45 | 75 |

Accordingly this skull is represented in four aspects on Plates I—IV‡. A more dolichocephalic type ($B/L = 70$), W. 76 ♂, is represented in Plates V—VII. This is by no means an extreme form: it does not present the lowness (see Plate V)

* *Biometrika*, Vol. I. p. 436.

† The photographs from which these illustrations were reproduced were taken by Professor Karl Pearson; it was a long and laborious piece of work, and my heartiest thanks are due to him for this addition to my paper. The cost of reproduction was defrayed from a grant placed at his disposal last year through the munificence of the Drapers' Company. Professor Pearson is further responsible for the drawing up of this section of my memoir. But its possibility is due entirely to the kindness of Professor Thane, who gave up a large portion of his valuable time to a close study of the special points of anatomical interest in the individual crania.

‡ The scales are here for *N. lateralis*, *N. basalis*, and *N. verticalis* two-thirds natural size and for *N. facialis* seven-eighths, but it was found impossible to maintain this accurately throughout the series as the focus must be an average focus, and the control of the engraver could not be complete. After some experimenting with various methods the idea of uniformity of scale was discarded in favour of getting the photograph with the clearest detail. In the case of the "special" skulls, the endeavour was made to get the special detail to be illustrated, at the expense very often of the remainder of the object and entirely of scale. In the case of the "normal" skulls, a uniform system of orientation has been attempted, based on the German horizontal plane, the auricular vertical plane, and the median plane of the skull. If, however, the skull supports are not to interfere with the effectiveness of the photograph, this orientation will not be absolutely exact. On the whole we believe that the real and invaluable advantage of photographic reproduction is to show the indescribable in type and abnormality; it cannot be properly used to replace an elaborate system of individual measurements.

of some of the very dolichocephalic English crania. It contrasts favourably with W. 88 ♂ which also has $B/L = 70$, but $H/L = 58$ as compared with the $H/L = 69$ of W. 76. Turning to more brachycephalic skulls of the same series we have pictured W. 163 ♂, a somewhat damaged but very interesting skull in Plates X—XIII, the *N. facialis* was of little use owing to the defect in the vault. Here $B/L$ reaches 80·5. It is interesting to note that this result is obtained by a great increase in breadth, in this case 153 mm., beyond that of the typical skull W. 76; the length remains the same. The like point is illustrated in Plates XIV and XV, where the racially brachycephalic skull W. 147 ♂ is given in *N. facialis* and *N. occipitalis*. The length is in this case 191 and breadth 148 with cephalic index 77·5. So that again the increased rotundity is not gained by loss of length. Lastly in Plates VIII and XI we give examples of two skulls W. 69 ♂ and W. 7101 ♂ of nearly average length, but with total heights above the average. W. 69 is racially dolichocephalic and W. 7101 racially brachycephalic, the indices being 71 and 79 respectively. The total lengths differ by only 2 mm. and the total heights by only 2 mm., but the difference in breadth amounts to upwards of 16 mm. This is another illustration of the great influence of absolute breadth in determining cephalic index within the race. Both W. 7101 and W. 69 are "fine" crania—if we look at them from the aspects which show the breadth and height in the first and the length and height in the second, i.e. the aspects shown in our photographs.

Turning to the female crania, Plates XXVII—XXXI give in five positions W. 149 ♀, a fairly typical English female skull. It is slightly larger than the average in length and breadth, but somewhat less in height, but the cephalic index 74·6 is practically identical with the 74·7 of the whole series. Plates XXV, XXVI give two views of W. 7044 ♀, which has precisely the same cephalic index 74·6, but while slightly less than the average in length and breadth has rather more than the average height. Thus the modal female skull of the series lies between W. 149 and W. 7044. To complete the general conception of the female skull we have selected a hyperdolichocephalic individual W. 10 ♀ with index 69 for reproduction in Plates XVI—XIX. This is by no means a very extreme type; the slight plagiocephaly and the infantile type of forehead render the skull otherwise of some interest. In W. 18 ♀, Plates XX—XXIV, we have a complete representation of a racially brachycephalic individual, cephalic index 79. This skull is again not extreme and while almost the average in both total and auricular heights, is less than the average in length and more in breadth.

We have endeavoured to give in these "normal" crania, some conception of the skulls of this English series. We have reproduced for both sexes modal individuals and then individuals deviating from the mode in the directions of greater dolichocephaly and of greater brachycephaly. It is open to the craniologist with a monomania for "types" to differentiate our series into two, three or more types on the basis of our illustrations. We have purposely offered the material upon which it can be done, because we believe that not only the tables of measurements, but familiarity with the material itself, will prove a complete and continuous linking

Normal Male Skull. W. 45.

N. facialis

Normal Male Skull. W. 45.

N. lateralis.

Normal Male Skull. W. 45.

N. basalis.

Normal Male Skull. W. 45.

N. verticalis.

Normal Male Skull. W. 76.

N. lateralis.

Normal Male Skull. W. 76.

N. basalis.

Normal Male Skull. W. 76.

N. verticalis.

Normal Male Skull. W. 7101.

N. occipitalis.

Normal Male Skull. W. 69.

N. lateralis.

Normal Male Skull. W. 163.

N. lateralis.

Normal Male Skull. W. 163.

N. basalis.

Normal Male Skull. W. 163.

N. verticalis.

Normal Male Skull. W. 163.

N. occipitalis.

Normal Male Skull. W. 147.

N. facialis.

Normal Male Skull. W. 147.

N. occipitalis.

Normal Female Skull. W. 10.

N. facialis.

Normal Female Skull. W. 10.

N. lateralis Young adult. Infantile type of Forehead.

Normal Female Skull. W. 10.

N. basalis.

Normal Female Skull. W. 10.

N. verticalis.

Normal Female Skull. W. 18.

N. facialis.

Normal Female Skull. W. 18.

N. lateralis.

Normal Female Skull. W. 18.

N. basalis.

Normal Female Skull. W. 18.

N. occipitalis.

Normal Female Skull. W. 7044.

N. facialis.

Normal Female Skull. W. 7044.

N. occipitalis.

Normal Female Skull. W. 149.

N. facialis.

Normal Female Skull. W. 149.

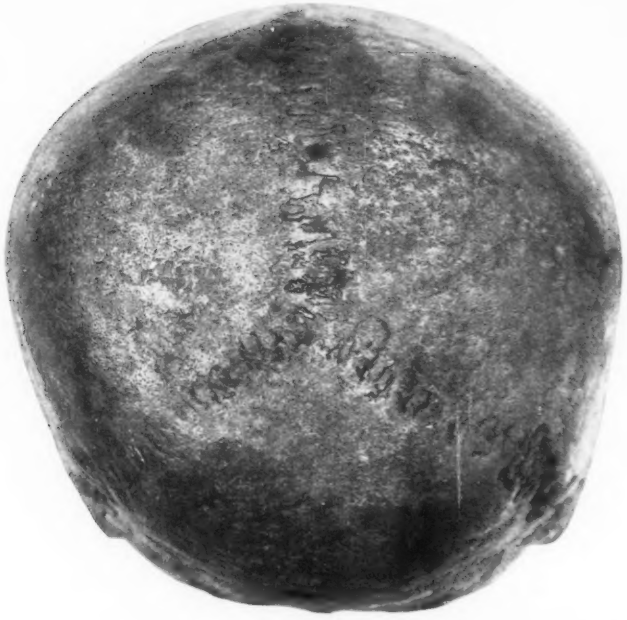
N. lateralis.

Normal Female Skull. W. 149.

N. basalis.

Normal Female Skull. W. 149.

N. verticalis.



Normal Female Skull. W. 149.

N. occipitalis.

Special Skull. W. 7042.

Ossicle of Bregma

Special Skull. W. 223.

Ossicle of Lambda.

Special Skull. W. 226.

Double Ossicle of Lambda.

Special Skull. W. 217.

Simple Interparietal.

Special Skull. W. 7096.

Tripartite Interparietal. Os pentagonale and ossa triangularia all separate.

Special Skull. W. 218.

Tripartite Interparietal. Ossa triangularia only separate.

Special Skull. W. 219.

Tripartite Interparietal. Os pentagonale and right Os triangulare separate.

Special Skull. W. 7052.

Triparfite Interparietal Os pentagonale and left os triangulare separate.

Special Skull. W. 221.

Tripartite Interparietal. Os pentagonale only separate.

Special Skull. W. 231.

Plagiocephaly.

Special Skull. W. 7042.

Bathrocephaly.

Special Skull. W. 7059.

Bathrocephaly with Ossicles of Lambdoid Suture. Left Profile.

Special Skull. W. 7042.

Bathrocephaly with Ossicles of Lambdoid Suture.

Special Skull. W. 7059.

Bathrocephaly with Ossicles of Lambdoid Suture. Right Profile.

Special Skull. W. 215.

Frontal Process of Temporal.

Special Skull. W. 214.

Unilateral Precondylar Eminence.

Special Skull. W. 213.

Bilateral precondylar Eminences.

Special Skull. W. 229.

Hamulus lacrimalis

Special Skull. W. 229.

Hamulus lacrimalis.

up for all characters between the individuals we have selected for representation, and that it is nowhere possible to draw a line and say, here one "type" begins and there another ends. Take the material, however, as a whole whether in our tables of means, or in our tables of measurements or in the plates, and compare it with other series, German, or French, or Scandinavian and we see at once that it has a very marked individuality of its own; that the English, or at any rate the London, skull of post-mediaeval times is a type *sui generis*. Whether this be the result of *Blutvermischung*, of selection or of environmental influence or of an absolute difference of ancestry it might be hard to determine. But the fact remains perfectly certain, the English modal skull is markedly differentiated from those at any rate of central and southern Europe.

### (*b*) *Special Crania.*

Out of the 292 skulls in this collection, 164 were noted as having some, it may be slight, anatomical peculiarities. As a rule such peculiarities were likely to occur in groups. Thus 280 peculiarities were recorded, or an average of ·96 to each skull in the series, and 1·71 to each skull specially recorded for abnormality. Of these abnormalities 151 were recorded in skulls supposed to be female and 129 in skulls supposed to be male; the total number of skulls adjudged female was 151 and adjudged male 141. In other words the abnormalities were on an average one to each female and ·91 to each male skull. It will thus be seen that what greater tendency there is to abnormal variation lies in the female rather than in the male skull. Here as in every case where really scientific methods are applied to the problem there seems no reason for asserting that men show a more marked variational tendency than women.

If we turn to the individual anomalies recorded, it may be noted that some of them are very slight, but still the general frequency of anomalous characters seems higher than in most long series of skulls. At first it appeared that possibly the fact noticed on p. 196 (iv) might explain this high frequency, but a second series of London skulls shows the same high, if not a higher, proportion. We are therefore forced to the conclusion that the English skull is probably remarkable for anomalous variations; in this respect no series we have yet examined appears its equal, except possibly the Esquimaux series at Oxford. Our photographs will show how wide a range of anomalous variation can be represented from this one group.

We shall now proceed to consider some of the individual cases, classifying them under:

(i) *Peculiarities of Form.*

A very frequent anomalous form consists in a *post coronal constriction*. We have spoken of this merely as a *post coronal depression*, if it is localised about the bregma. Post coronal constriction occurred in 19 crania, of which 15 were female, and 4 male, one of the latter being of very doubtful sex. Post coronal depression in 27

skulls of which 15 were female and 12 male. Of course depression passes insensibly into constriction, but the constriction is so markedly more a female than a male character, that for some time one was inclined to consider it might be due to some feminine habit of wearing a tight band round the head.

Depression of the obelion occurs in 19 skulls, of which 12 were female and 7 male; flattening of the obelion was noted in one male and a groove of the obelion in one male and one female skull. A coronal groove was also recorded in one male skull. There were isolated cases of parietal flattening and depression of the one or other frontal. A very marked inion was noted in eight cases, naturally the male crania having the majority of 5 to 3.

Plagiocephaly was recorded in five cases, three male and two female, and one of the latter is reproduced in Plate XLI. The peculiar shape of forehead which may be best described as a "marked infantile type" was found in four crania all female; one of these otherwise normal skulls is depicted in Plate XVII. The great length of the English skull is not a little due to the frequency of protuberant occiputs*, and these have been especially noted in our second series. It is further emphasised by the frequency of almost every degree of bathrocephaly. Fifteen bathrocephalic skulls, 9 male and 6 female, were recorded, and an equally high percentage was found in our second series. In 7 out of the 15 cases, bathrocephaly was combined with a more or less numerous system of ossicles in the lambdoid suture (Merkel). Plates XLII—XLV give fairly good representations of two female (W. 7042 and W. 7059) markedly bathrocephalic skulls.

A *torus occipitalis* was noted in 13 skulls, 7 males and 6 females.

Turning now to the neighbourhood of the *foramen magnum* a careful examination was made of the condyles, and single or paired precondylar eminences noted in 14 crania, 5 male and 9 female. One female skull showed a third condyle with articular facet (W. 170), and one male (W. 111) had the anterior extremities of the condyles united by an osseous bridge. This is illustrated in the sketch below as it was found impossible to obtain a satisfactory photograph.

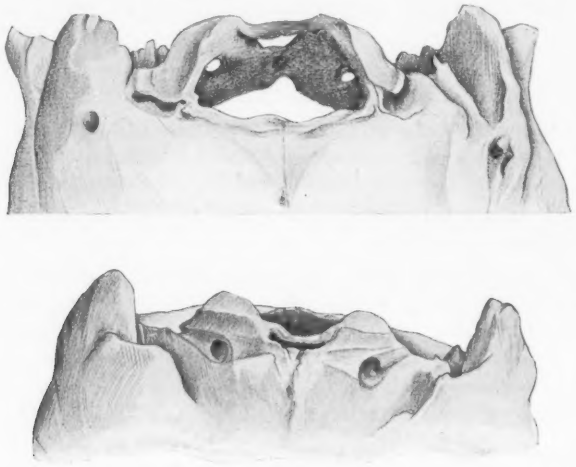
Plates XLVII and XLVIII illustrate cases of single and bilateral precondylar eminences. (*Condylus tertius?*)

Of other peculiarities we may note the rare case of the *hamulus lacrimalis* reaching the face figured in Plates XLIX and L; two cases of marked projection from hinder margin of external pterygoid plate (W. 85 ♂ and W. 86 ♀), two of the *porus crotaphitico-buccinatorius* of Hyrtl (W. 122 ♂ and W. 128 ♀), 5 cases of single or bilateral pterygospinous bridge, 3 male, 2 female; and isolated cases of imperfectly developed mandibular articulation (W. 57 ♀), *torus palatinus* (W. 149 ♀, see Plate XXIX), of subdivided *foramen ovale* (W. 173 ♂) and of markedly small right jugular foramen (W. 192 ♂ ? ?).

* Marked occipital projection occurred in four Whitechapel skulls, all four being female. Occipital flattening in one female skull.

(ii) *Ossicles and Wormian Bones.*

Ossicles of the bregma were recorded in 4 cases, 2 male and 2 female, and 1 case (associated with bathrocephaly) is depicted in Plate XXXII. Ossicles of the lambda occurred in 11 cases, 4 male and 7 female; cases of single and double ossicle



W. 111. Osseous Bridge of Condyles.

of the lambda are reproduced in Plates XXXIII and XXXIV. Ossicles of the asterion occurred in 2 female and 1 male case, and of the pterion in 13 cases, 6 male and 7 female. There was one case of a frontosphenoidal ossicle (W. 212 ♂), 1 case of ossicles in the parietal notches of temporals (W. 7061 ♀) and 1 case of ossicles between occipital, parietal and mastoid (W. 31 ♂). Ossicles were recorded in the coronal suture in 3 cases, all male; in the sagittal suture, in 2 male and 2 female cases; in the lambdoid suture in 29 cases, of which 13 were male and 16 female; the lambdoid suture had a very irregular line* in the male skull W. 76; in the squamous suture there were 2 male and 2 female cases of ossicles and 1 case (W. 7109 ♂) of ossicles in the parietomastoid suture. On the whole upwards of 75 cases of ossicles were noted, 37 male and 38 female. We may therefore say that slightly more than 25 per cent. of English skulls have one or more anomalous ossicles.

(iii) *Anomalies of the Sutures.*

Twenty-four skulls were metopic, or a persistent frontal suture was found in 9 male and 15 female skulls. The mean breadth and minimum forehead breadth of

* Complicated sutures were also noticed in skulls 204 ♂ and 76 ♂.

these 24 skulls were compared with the means for the whole series with the following results:

| Character | Male Skull | | Female Skull | |
|---|---|---|---|---|
| | General | Metopic | General | Metopic |
| Maximum Breadth ... | 141 | 142 | 135 | 135 |
| Least Forehead Breadth | 98 | 100 | 93 | 96 |

It would thus seem that a persistent frontal suture may allow of a two to three millimetres increase in the minimum forehead breadth, but probably does not influence the maximum cranial breadth.

We may perhaps note here that a metopic fontanelle occurred in one case, the male skull, W. 141.

Traces of a transverse-occipital suture were found in 3 cases and of an infra-orbital suture on the face in 2 cases, all males. In 1 female skull there was a division of the left parietal bone by a sinuous suture (W. 216), and in 3 cases, 1 male and 2 female, the apex of the occipital squama was produced upwards. Frontal process of temporal, single or bilateral, was noticed in 4 cases, 2 male and 2 female (see Plate XLVI) and a par-occipital process in 1 male skull (W. 192).

(iv) *Interparietals.*

As in the Esquimaux, the English skulls provide in both series a very considerable number of interparietals, in the Whitechapel series we have 5 male and 4 female. We may divide them into the simple interparietal, Plate XXXV, and the tripartite interparietal, Plate XXXVI. Skull W. 7096 is a good example of this although it is not as clearly shown in the plate as one might have wished. The complete tripartite interparietal consists as in skull W. 7096 of three parts. First the pentagonal shaped centre bone and then two triangular wings. These have been termed by Professor Thane the *os pentagonale* and the *ossa triangularia* respectively. Almost every form of this tripartite interparietal occurs in this English series. Thus we may have; (i) all three parts free as in Plate XXXVI. (ii) The *os pentagonale* fused and the *ossa triangularia* separate as in Plate XXXVII. (iii) The *os pentagonale* separate and the *ossa triangularia* fused as in Plate XL. (iv) The *os pentagonale* separate and the left *os triangulare* only separate, the right fused as in Plate XXXIX, or (v) the *os pentagonale* separate and the right *os triangulare* only separate, the left fused as in Plate XXXVIII. Cases of one *os triangulare* separate, and the other as well as the *os pentagonale* fused did not occur in this series. Still the series is so comprehensive and interesting that it seemed worth while to figure these interparietals fully, so that they may serve as standards for reference in other cases.

Taken as a whole the series appears to possess very considerable interest from the standpoint of special or "abnormal variations." The fact that the same high

percentages are maintained in a second English series seems to show that we are dealing with something at anyrate characteristic of the Londoner. It would be of interest to enquire whether the proportions of special variations are greater in mixed races like the English, than in races of relatively purer character.

### (9) *On the Variability of the English Skull.*

The numerical values of the variations are given in Table VII together with their probable errors.

Taking first the *capacity*, I extract various coefficients of variation from Pearson's *The Chances of Death*, Vol. I. pp. 328—349, for comparison with our series and the Naqadas.

| | ♂ | ♀ |
|---|---|---|
| English* ... ... ... | 8·28 | 8·68 |
| Parisian French ... ... | 7·36 | 7·10 |
| Modern Italians ... ... | 8·34 | 8·99 |
| Modern Germans ... ... | 7·74 | 8·19 |
| Naqadas ... ... ... | 7·72 | 6·92 |
| Etruscans ... ... ... | 9·58 | 8·54 |
| Egyptian Mummies ... | 8·13 | 8·29 |
| Ainos ... ... ... | 7·07 | 6·90 |

The variability of our series is high, but not quite so high as that of the Italians, and the female skull is slightly more variable than the male, the English in this respect resembling Italians and Germans.

Comparing the coefficients of variation of *length*, *breadth*, and *height* of the skull we find:

| Race | Length | | Breadth | | Auricular Height | |
|---|---|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| English ... | 3·31 | 3·45 | 3·75 | 3·54 | 3·73 | 4·12 |
| Bavarian† ... | 3·37 | 3·57 | 3·89 | 3·39 | 4·47 | 3·91 |
| French‡ ... | 3·97 | 3·65 | 4·21 | 3·67 | — | — |
| Naqada§ ... | 3·17 | 3·14 | 3·29 | 3·45 | 3·86 | 3·54 |
| Aino† ... | 3·20 | 3·08 | 2·76 | 2·68 | 3·67 | 3·18 |

* My own results are given; Pearson's figures were based on only 58 skulls—all that had been measured when he wrote.

† Alice Lee, *Phil. Trans.*, Vol. 196, A, p. 230.

‡ Unpublished reductions of measurements in Broca's MS., by C. D. Fawcett.

§ *Biometrika*, Vol. I. p. 438.

## TABLE VII.

*Variability of the English Skull.*

| Character | Male | | | Female | | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Coefficient of Variation | Mean | Standard Deviation | Coefficient of Variation |
| $C$ ... ... | 1476·94 ± 9·73 | 122·37 ± 6·88 | 8·28 ± ·47 | 1299·87 ± 8·51 | 112·80 ± 6·01 | 8·68 ± ·47 |
| $F$ ... ... | 187·35 ± ·35 | 6·17 ± ·25 | 3·29 ± ·13 | 180·14 ± ·36 | 6·38 ± ·25 | 3·54 ± ·14 |
| $L'$ ... ... | 187·76 ± ·45 | 5·64 ± ·32 | 3·00 ± ·17 | 180·07 ± ·57 | 6·33 ± ·40 | 3·52 ± ·22 |
| $L$ ... ... | 189·06 ± ·36 | 6·27 ± ·25 | 3·31 ± ·13 | 180·36 ± ·35 | 6·22 ± ·25 | 3·45 ± ·14 |
| $B$ ... ... | 140·67 ± ·31 | 5·28 ± ·22 | 3·75 ± ·15 | 134·68 ± ·27 | 4·77 ± ·19 | 3·54 ± ·14 |
| $B'$ ... ... | 98·02 ± ·25 | 4·20 ± ·17 | 4·29 ± ·17 | 93·12 ± ·23 | 4·23 ± ·17 | 4·55 ± ·18 |
| $H$ ... ... | 132·04 ± ·34 | 5·56 ± ·24 | 4·21 ± ·18 | 124·56 ± ·30 | 4·93 ± ·21 | 3·96 ± ·17 |
| $OH$ ... | 114·59 ± ·25 | 4·28 ± ·18 | 3·73 ± ·15 | 109·21 ± ·25 | 4·50 ± ·18 | 4·12 ± ·16 |
| $LB$ ... | 101·60 ± ·25 | 4·13 ± ·18 | 4·07 ± ·18 | 95·34 ± ·24 | 3·91 ± ·17 | 4·11 ± ·18 |
| $U$ ... ... | 524·25 ± ·88 | 15·02 ± ·63 | 2·87 ± ·12 | 503·84 ± ·85 | 14·70 ± ·60 | 2·92 ± ·12 |
| $S$ ... ... | 377·11 ± ·81 | 13·69 ± ·57 | 3·63 ± ·15 | 362·76 ± ·84 | 14·16 ± ·59 | 3·90 ± ·16 |
| $Q$ ... ... | 307·93 ± ·72 | 11·40 ± ·51 | 3·70 ± ·16 | 293·97 ± ·71 | 11·67 ± ·50 | 3·97 ± ·17 |
| $G'H$ ... | 70·17 ± ·30 | 3·86 ± ·21 | 5·50 ± ·30 | 65·93 ± ·40 | 4·71 ± ·28 | 7·14 ± ·43 |
| $GB$ ... | 90·87 ± ·45 | 5·07 ± ·32 | 5·58 ± ·36 | 84·86 ± ·41 | 4·59 ± ·29 | 5·40 ± ·34 |
| $J$ ... ... | 130·05 ± ·57 | 5·57 ± ·40 | 4·28 ± ·31 | 120·27 ± ·58 | 4·97 ± ·41 | 4·13 ± ·34 |
| $NH$ ... | 51·22 ± ·20 | 2·60 ± ·14 | 5·08 ± ·27 | 48·68 ± ·22 | 2·70 ± ·16 | 5·55 ± ·32 |
| $NB$ ... | 24·29 ± ·17 | 2·16 ± ·12 | 8·89 ± ·51 | 23·19 ± ·14 | 1·64 ± ·10 | 7·06 ± ·42 |
| $O_1L$ ... | 43·06 ± ·15 | 1·81 ± ·11 | 4·20 ± ·25 | 41·17 ± ·13 | 1·45 ± ·09 | 3·53 ± ·22 |
| $O_1R$ ... | 42·99 ± ·16 | 2·02 ± ·12 | 4·69 ± ·27 | 40·95 ± ·14 | 1·64 ± ·10 | 4·00 ± ·24 |
| $O_2L$ ... | 33·46 ± ·15 | 1·88 ± ·11 | 5·61 ± ·33 | 33·59 ± ·12 | 1·45 ± ·09 | 4·31 ± ·26 |
| $O_2R$ ... | 33·42 ± ·18 | 2·22 ± ·13 | 6·65 ± ·38 | 33·73 ± ·13 | 1·51 ± ·09 | 4·47 ± ·27 |
| $G_1$ ... ... | 48·27 ± ·22 | 2·74 ± ·16 | 5·68 ± ·33 | 45·13 ± ·26 | 2·95 ± ·19 | 6·53 ± ·41 |
| $G_2$ ... ... | 36·78 ± ·24 | 2·85 ± ·17 | 7·75 ± ·46 | 35·22 ± ·24 | 2·70 ± ·17 | 7·68 ± ·48 |
| $G_1'$ ... | 44·66 ± ·21 | 2·53 ± ·14 | 5·67 ± ·33 | 41·53 ± ·22 | 2·53 ± ·16 | 6·10 ± ·38 |
| $GL$ ... | 95·93 ± ·35 | 4·49 ± ·25 | 4·68 ± ·26 | 90·42 ± ·40 | 4·47 ± ·28 | 4·95 ± ·31 |
| $P\angle$ ... | 86°·09 ± ·33 | 3·92 ± ·24 | | 87°·13 ± ·27 | 2·85 ± ·19 | |
| $A\angle$ ... | 73°·38 ± ·28 | 3·41 ± ·20 | | 73°·90 ± ·29 | 3·31 ± ·21 | |
| $N\angle$ ... | 65°·19 ± ·29 | 3·52 ± ·20 | | 64°·70 ± ·23 | 2·53 ± ·16 | |
| $B\angle$ ... | 41°·43 ± ·20 | 2·50 ± ·14 | | 41°·39 ± ·27 | 2·98 ± ·19 | |
| $\theta_1$ ... ... | 28°·71 ± ·22 | 2·53 ± ·16 | | 28°·11 ± ·24 | 2·51 ± ·17 | |
| $\theta_2$ ... ... | 12°·92 ± ·29 | 3·34 ± ·21 | | 13°·13 ± ·34 | 3·60 ± ·24 | |
| $100B/L'$ ... | 75·17 ± ·24 | 2·97 ± ·17 | 3·95 ± ·23 | 74·62 ± ·27 | 3·01 ± ·19 | 4·03 ± ·26 |
| $100B/L$ ... | 74·34 ± ·19 | 3·26 ± ·14 | 4·38 ± ·18 | 74·73 ± ·18 | 2·98 ± ·12 | 3·99 ± ·17 |
| $100H/L'$ ... | 70·40 ± ·22 | 2·67 ± ·15 | 3·80 ± ·22 | 69·05 ± ·26 | 2·91 ± ·19 | 4·21 ± ·27 |
| $100H/L$ ... | 69·97 ± ·20 | 3·22 ± ·14 | 4·61 ± ·20 | 69·13 ± ·18 | 2·83 ± ·12 | 4·10 ± ·18 |
| $100H/B$ ... | 94·31 ± ·29 | 4·58 ± ·20 | 4·86 ± ·21 | 92·35 ± ·24 | 3·84 ± ·17 | 4·16 ± ·18 |
| $100B/H$ ... | 106·26 ± ·32 | 5·14 ± ·23 | 4·83 ± ·21 | 108·46 ± ·28 | 4·53 ± ·20 | 4·17 ± ·19 |
| $100G'H/GB$ | 76·52 ± ·50 | 5·39 ± ·35 | 7·04 ± ·46 | 77·94 ± ·57 | 6·26 ± ·41 | 8·04 ± ·52 |
| $100NB/NH$ | 47·55 ± ·37 | 4·58 ± ·26 | 9·64 ± ·55 | 47·79 ± ·33 | 3·90 ± ·23 | 8·16 ± ·49 |
| $100O_2/O_1 : L$ | 77·86 ± ·32 | 3·78 ± ·23 | 4·86 ± ·29 | 81·70 ± ·38 | 4·23 ± ·27 | 5·18 ± ·33 |
| $100O_2/O_1 : R$ | 77·69 ± ·38 | 4·66 ± ·27 | 6·00 ± ·35 | 82·46 ± ·37 | 4·33 ± ·26 | 5·25 ± ·32 |
| $100G_2/G_1$ ... | 76·26 ± ·55 | 6·40 ± ·39 | 8·39 ± ·52 | 77·69 ± ·62 | 6·62 ± ·44 | 8·52 ± ·57 |

The English skull closely resembles the Bavarian in variability of length and breadth, but there is a marked difference between the two as regards auricular height.

There are few data for comparison of the coefficients of variation of the *circumferential measurements*:

| Race | Horizontal Circumference | | Vertical Circumference | |
|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ |
| English ... ... ... | 2·87 | 2·92 | 3·70 | 3·97 |
| Bavarian* ... ... ... | 2·86 | 3·09 | — | — |
| Modern Badensians* ... | 3·02 | 2·34 | — | — |
| Row Grave German* ... | 2·70 | 2·40 | — | — |
| Naqada ... ... ... | 2·54 | 2·27 | 3·32 | 2·72 |

Here again we observe that English and Bavarian males are equally variable, and that the English female, unlike the Naqada, is more variable than the male in both circumferences. Relatively to the horizontal circumferences the greater variability in the vertical circumference is in our series very marked.

Comparing *length of palate*, we have the following coefficients of variation:

| Race | Length of Palate | |
|---|---|---|
| | ♂ | ♀ |
| English ... | 5·65 | 6·53† |
| ,, ... | 5·67 | 6·10‡ |
| Bavarian§ ... | 6·42 | 6·85 |
| Naqada ... | 6·49 | 7·41 |

The English and Bavarian differ considerably, but in all three races the female is the more variable.

For *profile angle*, we can compare the Bavarians and Naqadas:

| Race | Standard deviation of Profile angle | |
|---|---|---|
| | ♂ | ♀ |
| English ... | 3°·92 | 2°·85 |
| Bavarians ... | 2°·79 | 3°·59 |
| Naqada ... | 2°·87 | 3°·66 |

* Pearson: *The Chances of Death*, Vol. I. pp. 356—7.

† Length includes *spina*.

‡ Length excludes *spina*.

§ Pearson: *The Chances of Death*, Vol. I. p. 328.

While Bavarian and Naqada are closely alike, and the female in both races is the more variable, in our series the position of the sexes is reversed, the male being the more variable.

Next we have to compare *indices*: the following table of standard deviations contains the chief material available for comparison, which I extract from C. D. Fawcett's paper, p. 440:

| Race | *B/L* | | *H/L* | | *H/B* | |
|---|---|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| English ... ... ... | 3·26 | 2·98 | 3·22 | 2·83 | 4·58 | 3·84 |
| Bavarian ... ... | 3·50 | 2·97 | — | — | — | — |
| French .... ... ... | 4·43 | 4·19 | 3·53 | 3·67 | 4·74 | 4·31 |
| Naqada ... ... ... | 2·80 | 3·12 | 2·73 | 2·96 | 4·73 | 4·66 |
| Row Grave Germans ... | 2·28 | 2·35 | — | — | — | — |
| Aino ... ... ... | 2·41 | 2·54 | — | — | — | — |

Here again, so far as a comparison is possible, it appears that the variability of the English skulls is nearly the same as that of the Bavarian. It is to be noted, too, that in all three indices, the English female is less variable than the male.

For the remaining indices, the comparative data are meagre. We find the following standard deviations:

| Race | Upper Face Index | | Orbital Index | | Nasal Index | |
|---|---|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| English ... | 5·39 | 6·26 | *L* 3·78<br>*R* 4·66 | 4·23<br>4·33 | 4·58 | 3·90 |
| Bavarian* ... | 3·26 | 3 33 | 6·66 | 5·22 | 4·43 | 4·61 |
| Naqada ... | 4·52 | 4·15 | *L* 5·06<br>*R* 5·00 | 4·57<br>4·78 | 4·18 | 4 86 |

These figures show marked diversity of results. As compared with the Bavarians, the English have much greater variability in upper face index and much less in orbital index; and while in upper face index and nasal index the Bavarian female has nearly the same variability as the male, the English female is more variable in the former, and less so in the latter. In orbital index, too, the comparative variability of the two sexes is remarkable, and is complicated by the marked difference between the standard deviations of the two eyes in the English male.

* Pearson: *The Chances of Death*, Vol. I. pp. 325—328.

In the following characters I will compare the variability of our series with that of the Naqadas only, there being practically no material available for other races, and for this purpose I use *coefficients of variation.*

| | English | | Naqadas | |
|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ |
| $B'$ ... | 4·29 | 4·55 | 5·29 | 4·47 |
| $H$ ... | 4·21 | 3·96 | 3·98 | 3·66 |
| $LB$ ... | 4·07 | 4·11 | 4·88 | 4·68 |
| $S$ ... | 3·63 | 3·90 | 3·19 | 3·51 |
| $G'H$ ... | 5·50 | 7·14 | 6·08 | 6·87 |
| $GB$ ... | 5·58 | 5·40 | 5·18 | 4·77 |
| $J$ ... | 4·28 | 4·13 | 4·16 | 4·77 |
| $NH$ ... | 5·08 | 5·55 | 6·13 | 6·81 |
| $NB$ ... | 8·89 | 7·06 | 7·89 | 7·28 |
| $O_1L$ ... | 4·20 | 3·53 | 4·97 | 5·30 |
| $O_1R$ ... | 4·69 | 4·00 | 5·02 | 5·38 |
| $O_2L$ ... | 5·61 | 4·31 | 7·06 | 6·58 |
| $O_2R$ ... | 6·65 | 4·47 | 7·27 | 6·85 |
| $G_2$ ... | 7·75 | 7·68 | 9·29 | 8·55 |
| $GL$ ... | 4·68 | 4·95 | 4·84 | 5·09 |
| $100G_2/G_1$... | 8·39 | 8·52 | 10·23 | 8·20 |

In the midst of great diversity, some features emerge that are common to both races; e.g. the great variability of upper face height in females, of the breadth of the nose and palate in males and females, also of palatal index in both sexes. It is also noticeable that the variability of orbital height is much greater than that of orbital length in the males of both races.

I will conclude this part of the subject by dealing with the variability of the mandibles, for which I give a separate table as before:

## TABLE VIII.

*Variability of English Mandibles. Male and Female.*

| Character | Mean | Standard Deviation | Coefficient of Variation |
|---|---|---|---|
| $W_1$ | 113·21 ± ·41 | 6·31 ± ·29 | 5·57 ± ·26 |
| $W_2$ | 95·40 ± ·46 | 8·31 ± ·32 | 8·71 ± ·34 |
| $h_1$ | 30·76 ± ·21 | 3·61 ± ·15 | 11·73 ± ·49 |
| $f$ | 43·67 ± ·14 | 2·72 ± ·10 | 6·23 ± ·23 |

Comparing the coefficients of variation with those of the Naqada race, we find:

| Character | English | Naqada | | |
|---|---|---|---|---|
| | Male and Female | Male | Female | Male and Female |
| $W_1$ | 5·57 | 7·46 | 6·77 | 7·34 |
| $W_2$ | 8·71 | 7·62 | 7·19 | 8·11 |
| $h_1$ | 11·73 | 9·93 | 8·47 | 9·40 |
| $\zeta$ | 6·23 | 5·73 | 5·31 | 5·72 |

From these figures we may conclude that the English mandibles are more variable than the Naqadas in all the characters except $W_1$.

Summing up generally for the consideration of the variability, it is clear that our Whitechapel skulls have very much the same general degree of variation as the Bavarian. There is certainly no marked difference which would allow us to assert that this group is less homogeneous than the Altbayern of Professor Ranke. It would indeed be rash to assert that they are more or less variable than the Naqada. Far more data must be reduced for variability before we can see clearly where we stand. But when once tables of variation have been made out for 30 or 40 fairly long series of skulls we shall probably get a fairly good scale of relative homogeneity for many characters and so be able more easily to detect marked heterogeneity in cranial series.

### (10) *On the Nature of the Frequency Distribution.*

I will now discuss the variability of the series graphically and analytically, using the notation of Pearson's memoir on Skew Variation*. I have selected, for both sexes, the 12 characters dealt with by C. D. Fawcett†, and have added a thirteenth, viz., $B'$, or least breadth of forehead, but I do not propose to plot the 26 skew curves representing the distributions of these characters, because in most cases the normal curve represents the distribution with sufficient accuracy for all practical purposes, as I shall now proceed to show.

The following table gives the chief analytical constants of the skew curves for the 13 selected characters. The second column gives the number of skulls on which the calculation is based; the third shows the unit in terms of which the 2nd, 3rd, and 4th moments ($\mu_2$, $\mu_3$ and $\mu_4$) are calculated; after the moments follow columns giving $\beta_1$, $\sqrt{\beta_1}$ with its probable error, $\beta_2$ with its probable error, the difference between $\beta_2$ and the number 3, and the "criterion" $6+3\beta_1-2\beta_2$ with its probable error; the next three columns give the mean, the "mode," or value

* *Phil. Trans.* Vol. 186, A, pp. 343—414.

† *Loc. cit.*, p. 442.

for which the frequency is greatest, and the "skewness," or ratio of distance between mode and mean to standard deviation, with its probable error*.

Dealing first with the skewness, we observe that in 13 cases it is positive, or the mean is greater than the mode, and in 13 cases it is negative, or the mean is less than the mode. Further, in only two of the 13 cases of positive skewness, viz., *NB* ♂ and *H/L* ♀, and in only two of the 13 cases of negative skewness, viz., *H* ♂ and *G'H* ♂, can the skewness be considered as certainly significant when compared with the probable error; of the remaining cases two of the negative skewnesses, *L* ♀ and *U* ♀, and one of the positive, *NH* ♀, are perhaps significant; the rest are certainly insignificant. We cannot, therefore, conclude, as C. D. Fawcett was able to do with her Naqada skulls†, that if the mean and the mode do not coincide, the mean will be almost invariably greater than the mode. In our series if we were to draw the curves, the mean would be found in half the number of the curves to be less, and in the other half to be greater than the mode.

We will next examine the constants $\beta_1$ and $\beta_2$. If $\beta_1 = 0$ and $\beta_2 = 3$, the curve representing the distribution is the normal curve, and, therefore, in order to see how far the skew curves diverge from the normal we must first observe how much $\beta_1$ and $\beta_2$ differ from zero and 3 respectively, and then estimate the significance of the difference by comparing it with the respective probable errors. Columns 8, 9 and 10 enable us to make the comparison. Taking the $\sqrt{\beta_1}$ column first, we note that in only four cases out of the 26 is $\sqrt{\beta_1}$ certainly significant when compared with its probable error, and these four are precisely those which we have had occasion to notice as exceptional in regard to skewness, viz., *H* ♂, *G'H* ♂, *NB* ♂ and *H/L* ♀. In six cases $\sqrt{\beta_1}$ is greater, but not more than $1\frac{1}{2}$ times greater than the probable error, and in the remaining 16 cases $\sqrt{\beta_1}$ is less, sometimes very much less than the probable error.

A comparison of the $3-\beta_2$ column with the probable error of $\beta_2$ leads to similar results; in only three cases is the difference certainly significant; in the most unfavourable of the remaining cases the difference is less than twice the probable error. Similar remarks apply to a comparison of the criterion with its probable error.

Our examination of the constants of the curves thus confirms C. D. Fawcett's conclusion‡: *With series of skull measurements such as the present, which are long for the craniologist, if short for the statistician, we shall reach for most practical purposes adequate graphical representations of the frequency by using the normal curve of deviations,* $y = y_0 e^{-x^2/2\sigma^2}$.

This being the case, I do not propose to calculate and plot any of the skew curves, but will content myself with tracing two normal curves, the one repre-

* For the formulae for calculating these probable errors, see Pearson, *Phil. Trans.* Vol. 198, A, p. 278.

† C. D. Fawcett on p. 443 says only 5 out of 24 cases have *negative* skewness, her table shows 6, but this does not affect her argument.

‡ *Loc. cit.* p. 443.

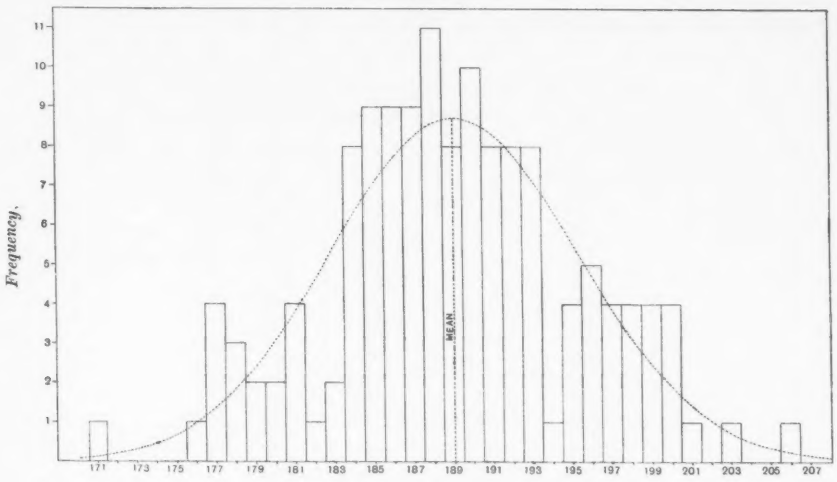
## TABLE IX.

*Analytical Constants of Curves.*

| Character | No. | Unit | $\mu_2$ | $\mu_3$ | $\mu_4$ | $\beta_1$ | $\sqrt{\beta_1}$ | $\beta_2$ | $3-\beta_2$ | Criterion | Mean | Mode | Skewness | Distance of Mean from Mode |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $L$ ♂ ... | *137* | 1 mm. | 39·2709 | − 6·4413 | 4562·103 | ·00068 | ·0262 ± ·1411 | 2·9582 ± ·2823 | ·0418 | ·0857 ± ·5646 | 189·06 | 189·14 | − ·0135 ± ·0706 | − ·0844 ± ·4426 |
| $L$ ♀ ... | *140* | 1 mm. | 38·6768 | − 52·3296 | 4650·972 | ·04733 | ·2175 ± ·1396 | 3·1091 ± ·2793 | − ·1091 | − ·0763 ± ·5585 | 180·36 | 181·02 | − ·1061 ± ·0698 | ·6600 ± ·4341 |
| $B$ ♂ ... | *135* | 1 mm. | 27·8697 | − 23·8924 | 3349·490 | ·02637 | ·1624 ± ·1422 | 4·3123 ± ·2844 | − 1·3123 | − 2·5456 ± ·5688 | 140·67 | 140·92 | − ·0479 ± ·0711 | − ·2527 ± ·3754 |
| $B$ ♀ ... | *140* | 1 mm. | 22·7776 | 4·7849 | 1391·762 | ·00194 | ·0440 ± ·1396 | 2·6825 ± ·2793 | ·3175 | ·6407 ± ·5585 | 134·68 | 134·54 | ·0284 ± ·0698 | ·1357 ± ·3329 |
| $B'$ ♂ ... | *132* | 1 mm. | 17·6813 | 5·7205 | 982·701 | ·00592 | ·0769 ± ·1438 | 3·1433 ± ·2876 | − ·1433 | − ·2689 ± ·5752 | 98·02 | 97·87 | ·0354 ± ·0719 | ·1487 ± ·3020 |
| $B'$ ♀ ... | *147* | 1 mm. | 17·9237 | − 2·2559 | 913·379 | ·00088 | ·0297 ± ·1363 | 2·8431 ± ·2725 | ·1569 | ·3164 ± ·5451 | 93·12 | 93·19 | − ·0166 ± ·0682 | − ·0742 ± ·2885 |
| $H$ ♂ ... | *122* | 1 mm. | 30·9068 | − 52·0149 | 2676·625 | ·09164 | ·3027 ± ·1496 | 2·8021 ± ·2992 | ·1979 | ·6708 ± ·5983 | 132·04 | 133·13 | − ·1969 ± ·0748 | − 1·0946 ± ·4159 |
| $H$ ♀ ... | *124* | 1 mm. | 24·3409 | 21·5954 | 1944·593 | ·03234 | ·1798 ± ·1484 | 3·2821 ± ·2967 | − ·2821 | − ·4672 ± ·5935 | 124·56 | 124·17 | ·0783 ± ·0742 | ·3862 ± ·3658 |
| $OH$ ♂ ... | *135* | 1 mm. | 18·3062 | ·8921 | 864·324 | ·00013 | ·0114 ± ·1422 | 2·5792 ± ·2844 | ·4208 | ·8421 ± ·5688 | 114·59 | 114·56 | ·0082 ± ·0711 | ·0349 ± ·3043 |
| $OH$ ♀ ... | *143* | 1 mm. | 20·2173 | − 4·9820 | 1153·463 | ·00300 | ·0548 ± ·1382 | 2·8220 ± ·2764 | ·1780 | ·3650 ± ·4528 | 109·21 | 109·35 | − ·0313 ± ·0691 | − ·1408 ± ·3109 |
| $U$ ♂ ... | *131* | 3 mm. | 25·0799 | 16·8212 | 1930·670 | ·01793 | ·1339 ± ·1443 | 3·0694 ± ·2886 | − ·0694 | − ·0850 ± ·5772 | 524·25 | 523·27 | ·0651 ± ·0722 | ·9784 ± 1·0844 |
| $U$ ♀ ... | *136* | 3 mm. | 24·0096 | − 22·2282 | 1799·619 | ·03570 | ·1889 ± ·1417 | 3·1218 ± ·2834 | − ·1218 | − ·1366 ± ·5668 | 503·82 | 505·15 | − ·0904 ± ·0709 | − 1·3294 ± 1·0422 |
| $S$ ♂ ... | *131* | 3 mm. | 20·8174 | ·7925 | 1257·431 | ·00007 | ·0084 ± ·1443 | 2·9021 ± ·2886 | ·0979 | ·1959 ± ·5772 | 377·11 | 377·04 | ·0045 ± ·0722 | ·0613 ± ·9884 |
| $S$ ♀ ... | *130* | 3 mm. | 22·2711 | − 4·9740 | 1469·983 | ·00224 | ·0473 ± ·1449 | 2·9637 ± ·2898 | ·0363 | ·0794 ± ·5796 | 362·76 | 363·10 | − ·0243 ± ·0725 | − ·3441 ± 1·0266 |
| $Q$ ♂ ... | *115* | 3 mm. | 14·4510 | − 10·8254 | 740·293 | ·03883 | ·1970 ± ·1541 | 3·5449 ± ·3082 | − ·5449 | − ·9734 ± ·6164 | 307·93 | 308·80 | − ·0759 ± ·0772 | − ·8661 ± ·8801 |
| $Q$ ♀ ... | *122* | 3 mm. | 15·1406 | − 3·8293 | 704·922 | ·00422 | ·0650 ± ·1496 | 3·0751 ± ·2992 | − ·0751 | − ·1375 ± ·5983 | 293·97 | 294·33 | − ·0311 ± ·0748 | − ·3627 ± ·8729 |
| $G'H$ ♂ ... | *75* | 1 mm. | 14·9222 | − 30·1774 | 762·216 | ·27407 | ·5235 ± ·1908 | 3·4230 ± ·3816 | − ·4230 | − ·0238 ± ·7632 | 70·17 | 71·17 | − ·2598 ± ·0954 | − 1·0037 ± ·3682 |
| $G'H$ ♀ ... | *62* | 1 mm. | 22·1544 | − 14·6309 | 1244·756 | ·01968 | ·1403 ± ·2098 | 2·5361 ± ·4196 | ·4639 | ·9869 ± ·8392 | 65·93 | 66·45 | − ·1090 ± ·1049 | − ·5131 ± ·4941 |
| $NH$ ♂ ... | *79* | 1 mm. | 6·7727 | ·8949 | 155·477 | ·00258 | ·0508 ± ·1859 | 3·3896 ± ·3718 | − ·3896 | − ·7714 ± ·7436 | 51·22 | 51·17 | ·0204 ± ·0930 | ·0532 ± ·2418 |
| $NH$ ♀ ... | *67* | 1 mm. | 7·3137 | 4·5942 | 161·147 | ·05395 | ·2323 ± ·2018 | 3·0126 ± ·4036 | − ·0126 | ·1366 ± ·8072 | 48·68 | 48·35 | ·1216 ± ·1009 | ·3290 ± ·2724 |
| $NB$ ♂ ... | *70* | 1 mm. | 4·6636 | 8·6651 | 121·478 | ·74025 | ·8604 ± ·1975 | 5·5854 ± ·3950 | − 2·5854 | − 2·9500 ± ·7900 | 24·28 | 23·73 | ·2550 ± ·0988 | ·5506 ± ·2134 |
| $NB$ ♀ ... | *64* | 1 mm. | 2·6832 | ·0200 | 16·684 | ·00002 | ·0045 ± ·2065 | 2·3173 ± ·4130 | ·6827 | 1·3654 ± ·8260 | 23·20 | 23·19 | ·0047 ± ·1033 | ·0077 ± ·1694 |
| $100B/L$ ♂ | *131* | ½ point | 42·5105 | 10·2971 | 6276·633 | ·00138 | ·0372 ± ·1443 | 3·4732 ± ·2886 | − ·4732 | − ·9423 ± ·5772 | 74·34 | 74·29 | ·0144 ± ·0722 | ·0469 ± ·2354 |
| $100B/L$ ♀ | *130* | ½ point | 35·5465 | 13·3830 | 3297·173 | ·00399 | ·0632 ± ·1449 | 2·6094 ± ·2898 | ·3906 | ·7931 ± ·5796 | 74·73 | 74·60 | ·0440 ± ·0725 | ·1312 ± ·2160 |
| $100H/L$ ♂ | *120* | ½ point | 41·5789 | − 20·4340 | 6595·303 | ·00581 | ·0762 ± ·1508 | 3·8149 ± ·3016 | − ·8149 | − 1·6124 ± ·6032 | 69·97 | 70·05 | − ·0259 ± ·0754 | ·0834 ± ·2428 |
| $100H/L$ ♀ | *117* | ½ point | 32·1325 | 74·3841 | 2883·140 | ·16677 | ·4084 ± ·1527 | 2·7924 ± ·3054 | ·2076 | ·9155 ± ·6108 | 69·13 | 68·28 | ·2986 ± ·0764 | ·8462 ± ·2162 |

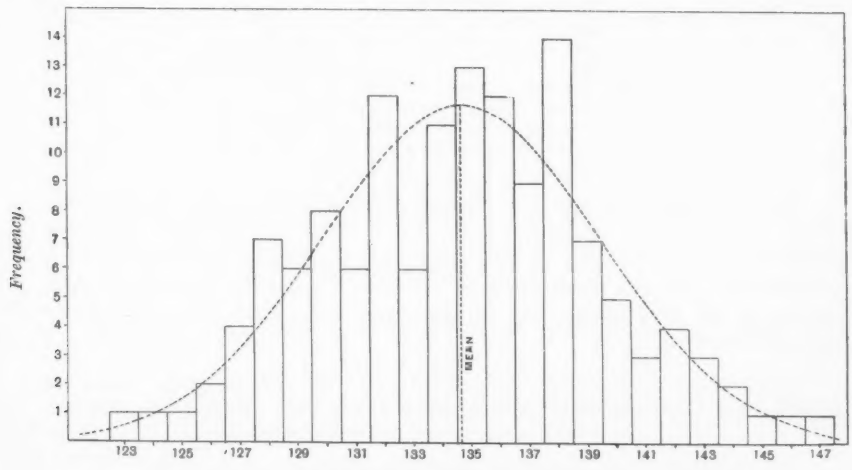
senting the distribution of $L$ ♂, the other that of $B$ ♀ (Diagrams I. and II.). As usual, the $y$ unit is one individual per unit of $x$, and the $x$ unit is 1 mm. The scale of absolute frequency indicated on the vertical to the left of the diagram gives $y$.

DIAGRAM I.




*Length of Head in Male Crania.*

DIAGRAM II.




*Breadth of Head in Female Crania.*

Dealing first with the $L\sigma^{\prime}$ normal curve—the general equation $y = y_0 e^{-x^2/2\sigma^2}$, where $y_0 = \dfrac{137}{\sigma\sqrt{2\pi}}$ and $\sigma = 6{\cdot}26665$, becomes $y = 8{\cdot}7216e^{-{\cdot}01273x^2}$, and the origin is at 189·06 mm. I will now apply Pearson's test of goodness of fit to the curve*. The following table shows the observed frequencies ($m_r'$), the frequencies calculated from the curve ($m_r$), and the ratio $(m_r - m_r')^2/m_r$:

| mm. | Observed | Calculated | $\frac{(m_r - m_r')^2}{m_r}$ |
|---|---|---|---|
| *176* and under | 2 | 3·1 | ·39 |
| *177* | 4 | 1·4 | 4·83 |
| *178* | 3 | 1·8 | ·80 |
| *179* | 2 | 2·4 | ·07 |
| *180* | 2 | 3·1 | ·39 |
| *181* | 4 | 3·8 | ·01 |
| *182* | 1 | 4·6 | 2·82 |
| *183* | 2 | 5·5 | 2·23 |
| *184* | 8 | 6·3 | ·46 |
| *185* | 9 | 7·1 | ·51 |
| *186* | 9 | 7·7 | ·22 |
| *187* | 9 | 8·2 | ·08 |
| *188* | 11 | 8·6 | ·67 |
| *189* | 8 | 8·7 | ·06 |
| *190* | 10 | 8·6 | ·23 |
| *191* | 8 | 8·3 | ·01 |
| *192* | 8 | 7·8 | ·005 |
| *193* | 8 | 7·1 | ·11 |
| *194* | 1 | 6·4 | 4·57 |
| *195* | 4 | 5·6 | ·46 |
| *196* | 5 | 4·7 | ·02 |
| *197* | 4 | 3·9 | ·003 |
| *198* | 4 | 3·1 | ·26 |
| *199* | 4 | 2·5 | ·90 |
| *200* | 4 | 1·9 | 2·32 |
| *201* | 1 | 1·4 | ·11 |
| *202* and over | 2 | 3·4 | ·58 |
| Totals | 137 | 137 | 23·12 |

Here the number of groups is 27, and $\chi^2 = 23{\cdot}12$, and turning to Elderton's Tables† we find for $n' = 27$ and $\chi^2 = 23$, that $P = {\cdot}632947$; that is, if our series of English skulls obeyed the "normal" frequency distribution for the character $L$ the frequency polygon would be more "peaked" in about 63 out of 100 trial samples of 137 skulls each. The normal curve, therefore, fits the observations quite satisfactorily.

It is unnecessary to discuss the normal curve for $B\varphi$ in great detail; its equation is $y = 11{\cdot}7026e^{-{\cdot}02195x^2}$, with centre at 134·68 mm. In this case $\chi^2 = 9{\cdot}89$

* *Phil. Mag.* Vol. I. pp. 157—175 (July, 1900), and *Biometrika*, Vol. I. p. 155.
† *Biometrika*, Vol. I. p. 161.

and $n' = 25$, and therefore from Elderton's Table $P = \cdot 99$; that is, in 99 out of every 100 trials we should get a more peaked polygon than the one representing the actual observations. The fit may therefore be considered perfect.

These two illustrations show that we must be most cautious in using the peaked or multimodal appearance of a polygon representing the distribution of a character in a short series of crania, as an argument in favour of heterogeneity of race, seeing that the peaks may well be due entirely to random sampling*.

In view of Pearson's article in *Biometrika*, Vol. II. Part III. on "Professor Aurel von Török's attack on the Arithmetical Mean," I have added to Table IX. a column showing the difference between the mean and the mode, and its probable error. Looking at the absolute values of the difference, we observe that in only three cases does it exceed 1 mm. In most of the remaining cases it is only a very small fraction of a millimetre or a point, and when compared with its probable error is quite insignificant.

### (11) *On the Correlation of Cranial Characters.*

In addition to the 27 pairs of characters which C. D. Fawcett exhibited in her Table XIII.†, I have selected seven other pairs of important characters, and in arriving at the 34 coefficients of correlation I have calculated the sum of the products of the pairs of measurements, instead of forming correlation tables; by this method, somewhat greater accuracy is attained, especially in dealing with circumferences and indices. Thus, let $a$, $b$ be the measurements of two characters in an individual; $M_1$ and $M_2$ the means, and $\sigma_1$ and $\sigma_2$ the standard deviations of the characters, $N$ the total number of individuals; then $r$, the coefficient of correlation, $= S(xy)/N\sigma_1\sigma_2$, and

$$\begin{aligned}\frac{S(xy)}{N} &= S(M_1 - a)(M_2 - b)/N \\ &= S(M_1M_2 - aM_2 - bM_1 + ab)/N \\ &= \{NM_1M_2 - M_2S(a) - M_1S(b) + S(ab)\}/N \\ &= \frac{S(ab)}{N} - M_1M_2.\end{aligned}$$

The following table gives the coefficients of correlation, and includes C. D. Fawcett's Table XIII. for the sake of comparison.

* See C. D. Fawcett, *loc. cit.* p. 454, and Pearson in *Biometrika*, Vol. II. pp. 341—343, where he deals with greatest forehead breadth and greatest skull breadth in 2000 Hungarian skulls.

† *Loc. cit.* p. 455.

## TABLE X.

*Correlation of Cranial Characters.*

| Pair of Characters | Whitechapel English | | | | Naqadas | | | |
|---|---|---|---|---|---|---|---|---|
| | No. | ♂ | No. | ♀ | No. | ♂ | No. | ♀ |
| *L* & *H* ... ... | *120* | ·255 ± ·058 | *117* | ·425 ± ·051 | *134* | ·489 ± ·044 | *163* | ·283 ± ·048 |
| *L* & *B* ... ... | *131* | ·240 ± ·055 | *130* | ·350 ± ·052 | *139* | ·344 ± ·050 | *183* | ·143 ± ·049 |
| *B* & *H* ... ... | *116* | ·233 ± ·059 | *115* | ·340 ± ·056 | *129* | ·273 ± ·055 | *163* | ·119 ± ·052 |
| *C* & *H* ... ... | *72* | ·501 ± ·059 | *78* | ·600 ± ·049 | *86* | ·642 ± ·043 | *114* | ·519 ± ·046 |
| *C* & *B* ... ... | *72* | ·631 ± ·048 | *80* | ·646 ± ·044 | *89* | ·434 ± ·058 | *123* | ·532 ± ·044 |
| *C* & *L* ... ... | *72* | ·597 ± ·051 | *78* | ·691 ± ·040 | *89* | ·501 ± ·054 | *123* | ·599 ± ·039 |
| *C* & *Q* ... ... | *72* | ·812 ± ·027 | *79* | ·744 ± ·034 | *84* | ·656 ± ·042 | *118* | ·603 ± ·039 |
| *C* & *U* ... ... | *72* | ·820 ± ·026 | *80* | ·848 ± ·021 | *84* | ·681 ± ·040 | *115* | ·723 ± ·030 |
| *C* & *S* ... ... | *72* | ·714 ± ·039 | *77* | ·811 ± ·026 | — | — | — | — |
| *C* & (*S* × *U* × *Q*) ... | *72* | ·879 ± ·018 | *77* | ·886 ± ·016 | — | — | — | — |
| *Q* & *S* ... ... | *108* | ·666 ± ·036 | *109* | ·581 ± ·043 | — | — | — | — |
| *U* & *S* ... ... | *124* | ·804 ± ·021 | *124* | ·827 ± ·019 | — | — | — | — |
| *U* & *Q* ... ... | *110* | ·720 ± ·031 | *114* | ·615 ± ·039 | *84* | ·512 ± ·054 | *115* | ·454 ± ·050 |
| $O_1$ & $O_2$ (*L*) ... | *63* | ·535 ± ·061 | *57* | ·161 ± ·087 | *81* | ·434 ± ·061 | *108* | ·477 ± ·050 |
| $O_1$ & $O_2$ (*R*) ... | *68* | ·462 ± ·064 | *62* | ·244 ± ·080 | *82* | ·405 ± ·062 | *112* | ·510 ± ·047 |
| *NB* & *NH* ... | *70* | ·146 ± ·079 | *64* | ·182 ± ·081 | *84* | ·343 ± ·065 | *116* | ·125 ± ·061 |
| $G_1$ & $G_2$ ... | *61* | ·214 ± ·082 | *51* | ·255 ± ·088 | *73* | ·202 ± ·076 | *105* | ·501 ± ·049 |
| *GH* & *GB* ... | *53* | ·189 ± ·089 | *54* | ·225 ± ·087 | *77* | ·385 ± ·065 | *101* | ·479 ± ·050 |
| *H*/*L* & *NB*/*NH* ... | *65* | ·256 ± ·078 | *57* | −·141 ± ·088 | *71* | −·050 ± ·080 | *107* | −·132 ± ·064 |
| *H*/*L* & $O_2/O_1$ (*L*) ... | *58* | −·325 ± ·079 | *53* | −·057 ± ·092 | *70* | ·175 ± ·078 | *100* | −·002 ± ·067 |
| *H*/*L* & $O_2/O_1$ (*R*) ... | *63* | −·243 ± ·080 | *56* | ·102 ± ·089 | *73* | ·170 ± ·077 | *102* | −·016 ± ·067 |
| *H*/*L* & $G_2/G_1$ ... | *56* | −·121 ± ·089 | *44* | −·168 ± ·099 | *59* | ·148 ± ·086 | *87* | −·041 ± ·072 |
| *B*/*L* & *NB*/*NH* ... | *66* | ·177 ± ·080 | *57* | −·212 ± ·085 | *75* | −·148 ± ·076 | *110* | −·050 ± ·064 |
| *B*/*L* & $O_2/O_1$ (*L*) ... | *59* | −·159 ± ·086 | *52* | ·003 ± ·093 | *72* | ·106 ± ·079 | *102* | −·085 ± ·066 |
| *B*/*L* & $O_2/O_1$ (*R*) ... | *65* | −·079 ± ·083 | *54* | −·001 ± ·092 | *74* | ·165 ± ·076 | *104* | −·036 ± ·066 |
| *B*/*L* & $G_2/G_1$ ... | *56* | −·189 ± ·087 | *43* | ·056 ± ·102 | *60* | ·317 ± ·078 | *88* | ·109 ± ·071 |
| *NB*/*NH* & $O_2/O_1$ (*L*) | *60* | −·301 ± ·079 | *55* | −·186 ± ·088 | *77* | −·276 ± ·071 | *111* | −·263 ± ·060 |
| *NB*/*NH* & $O_2/O_1$ (*R*) | *60* | −·456 ± ·069 | *58* | −·258 ± ·083 | *76* | −·323 ± ·069 | *113* | −·279 ± ·059 |
| *NB*/*NH* & $G_2/G_1$ ... | *56* | ·081 ± ·089 | *50* | −·014 ± ·095 | *67* | −·194 ± ·079 | *97* | ·026 ± ·068 |
| $G_2/G_1$ & $O_2/O_1$ (*L*)... | *52* | −·230 ± ·089 | *43* | −·052 ± ·103 | *62* | ·118 ± ·085 | *93* | ·108 ± ·069 |
| $G_2/G_1$ & $O_2/O_1$ (*R*)... | *49* | −·221 ± ·092 | *44* | −·115 ± ·100 | *65* | ·177 ± ·081 | *94* | ·216 ± ·066 |
| *B* & *B'* ... ... | *127* | ·432 ± ·049 | *137* | ·367 ± ·050 | *52* | ·111* | — | — |
| *B* & *J* ... ... | *43* | ·468 ± ·080 | *32* | ·414 ± ·099 | *52* | ·044* | — | — |
| *B'* & *J* ... ... | *42* | ·620 ± ·064 | *33* | ·497 ± ·088 | *52* | ·569* | — | — |

This table shows that our series of English skulls agrees with that of the Naqadas in having a low degree of correlation between most of the characters selected for examination. In this respect the skull differs markedly from the long bones of the leg and arm†. For example, it has been found that in 100 French male and female skeletons the coefficients of correlation between the long bones

* *Biometrika*, Vol. II. p. 350.

† Fawcett, *loc. cit.* p. 455, and Lee and Pearson, *Phil. Trans.* Vol. 196, pp. 228, 229.

## TABLE XI.

| Series | *L* and *H* | | | | *L* and *B* | | | | *B* and *H* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ♂ | | ♀ | | ♂ | | ♀ | | ♂ | | ♀ | |
| | No. | | No. | | No. | | No. | | No. | | No. | |
| Whitechapel English ... | *120* | ·255 ± ·058 | *117* | ·425 ± ·051 | *131* | ·240 ± ·055 | *130* | ·350 ± ·052 | *116* | ·233 ± ·059 | *115* | ·340 ± ·056 |
| French ‡ ... ... ... | *860* | ·294 ± ·022 | *340* | ·132 ± ·036 | *860* | ·089 ± ·024 | *340* | −·042 ± ·037 | *860* | ·224 ± ·023 | *340* | ·229 ± ·035 |
| German § ... ... ... | *100* | [−·096 ± ·067]* | *99* | [·314 ± ·061]* | *100* | ·286 ± ·062 | *99* | ·488 ± ·052 | *100* | [·072 ± ·067]* | *99* | [·276 ± ·063]* |
| English (Criminals) ‖ ... | — | — | — | — | *3000* | [·402 ± ·010]† | — | — | — | — | — | — |
| English (Middle Classes) ‖ | — | — | — | — | *1000* | [·345 ± ·019]† | — | — | — | — | — | — |
| Aino § ... ... ... | *87* | [ ·501 ± ·054]* | *63* | [·349 ± ·075]* | *87* | ·432 ± ·059 | *63* | ·376 ± ·073 | *87* | [·345 ± ·064]* | *63* | [·178 ± ·082]* |
| Naqada ¶ ... ... ... | *134* | ·489 ± ·044 | *163* | ·283 ± ·048 | *139* | ·344 ± ·050 | *183* | ·143 ± ·049 | *129* | ·273 ± ·055 | *163* | ·119 ± ·052 |

* Auricular and not total height used and so not properly comparable.
† Measurements on living head and not skull.
‡ See footnote, p. 239.
§ See A. Lee: *Phil. Trans.* Vol. 196, A, p. 231.
‖ Macdonell: *Biometrika*, Vol. I. pp. 181 and 188.
¶ C. D. Fawcett: *Biometrika, loc. cit.*, p. 455.

ranged from ·74 to ·98*. A similarly high correlation has also been shown to exist between the first finger joints, the coefficients ranging from ·82 to ·91†.

I will now examine in detail the results shown in the Table, and compare them with the results obtained for other races, incorporating in my tables the comparable material which C. D. Fawcett collected in her Tables XV., XVI. and XVII.

*Length, Breadth and Height Correlations.*

In the English series we observe that the females are much more highly correlated than the males in all three pairs of characters. In this respect they agree with the German series, but here the comparison is unsatisfactory so far as height is concerned, the German height being auricular, the English basio-bregmatic. English also agree with Naqada in so far as $L$ and $H$ is the most closely associated pair in both races. On the other hand, it is the males who are the more highly correlated throughout in Ainos and Naqadas, and also in French except for the pair $B$ and $H$, where the sexes agree; here again, however, it must be noted that in the case of the Ainos we are dealing with the auricular height.

In absolute value of the correlation coefficients we observe that our series agrees fairly closely with the French in the pairs $L$ and $H$♂ and $B$ and $H$♀ and with the German in $L$ and $B$♂, but in no others.

*Correlation of Breadths.*

Little has hitherto been done in working out the correlation between cephalic ($B$), frontal ($B'$) and bizygomatic ($J$) breadths: the following table gives all the material that I have been able to find:

TABLE XII.

*Correlation of Head Breadths.*

| Race | $B$ and $B'$ | | $B$ and $J$ | | $B'$ and $J$ | |
|---|---|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| English | ·432 | ·367 | ·468 | ·414 | ·620 | ·497 |
| Naqadas ‡ | ·111 | — | ·044 | — | ·569 | — |
| Theban Mummies ‡ | ·298 | — | ·250 | — | ·342 | — |
| Oraon Tribe ‡ (living head) | ·587 | — | ·409 | — | ·554 | — |

There is fairly close agreement between English skulls and living Oraons in all three correlation coefficients. The correlation between frontal and bizygomatic breadths is very much the same in Naqadas as in English and Oraons, and in all

* Lee and Pearson: *R. S. Proc.* Vol. 61, pp. 349, 350.

† Whiteley and Pearson: *R. S. Proc.* Vol. 65, p. 130. See also Lewenz and Whiteley: *Biometrika*, Vol. I. pp. 345—60.

‡ *Biometrika*, Vol. II. pp. 349—351.

four races it is greater than that between cephalic and bizygomatic breadths. The low correlation between $B$ and $B'$, and $B$ and $J$ in the two Egyptian series, especially in the Naqadas, is to be noted.

In the English, the female is less highly correlated than the male.

*Correlations of Capacity.*

TABLE XIII.

*Capacity and Height, Breadth and Length.*

| Race | $C$ and $H$ | | | | $C$ and $B$ | | | | $C$ and $L$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ♂ | | ♀ | | ♂ | | ♀ | | ♂ | | ♀ | |
| | No. | | No. | | No. | | No. | | No. | | No. | |
| English | *72* | ·501 ± ·059 | *78* | ·600 ± ·049 | *72* | ·631 ± ·048 | *80* | ·646 ± ·044 | *72* | ·597 ± ·051 | *78* | ·691 ± ·040 |
| Naqada | *86* | ·642 ± ·043 | *114* | ·519 ± ·046 | *89* | ·434 ± ·058 | *123* | ·532 ± ·044 | *89* | ·501 ± ·054 | *123* | ·599 ± ·039 |
| German | *100* | ·243 ± ·064 | *99* | ·451 ± ·054 | *100* | ·672 ± ·037 | *99* | ·706 ± ·034 | *100* | ·515 ± ·050 | *99* | ·687 ± ·037 |
| Aino | *76* | ·544 ± ·054 | *52* | ·521 ± ·068 | *76* | ·561 ± ·053 | *52* | ·502 ± ·070 | *76* | ·893 ± ·016 | *52* | ·663 ± ·053 |
| Sioux | *57* | ·440 ± ·070 | — | — | *57* | ·67 ± ·05 | — | — | *57* | ·54 ± ·06 | — | — |
| Means | | ·48 | | ·52 | | ·60 | | ·59 | | ·61 | | ·66 |

There is no striking difference between the sexes in our series, such as exists between German ♂ and ♀ in the pair $C$ and $H$, and Aino ♂ and ♀ in $C$ and $L$, but here again the English female is more highly correlated than the male, in this respect again agreeing with the Germans throughout, and also with the Naqadas except in the pair $C$ and $H$. In Ainos the position is reversed. the male being the more highly correlated.

We have only Naqadas and Theban mummies for comparison in the case of capacity and circumferences.

TABLE XIV.

*Capacity and Circumferences.*

| Race | $C$ and $U$ | | | | $C$ and $Q$ | | | | $C$ and $S$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ♂ | | ♀ | | ♂ | | ♀ | | ♂ | | ♀ | |
| | No. | | No. | | No. | | No. | | No. | | No. | |
| English | *72* | ·820 ± ·026 | *80* | ·848 ± ·021 | *72* | ·812 ± ·027 | *79* | ·744 ± ·034 | *72* | ·714 ± ·039 | *77* | ·811 ± ·026 |
| Naqada | *84* | ·681 ± ·040 | *115* | ·723 ± ·030 | *84* | ·656 ± ·042 | *118* | ·603 ± ·039 | — | — | — | — |
| Theban Mummies | *202* | ·813 ± ·016 | *96* | ·826 ± ·022 | *202* | ·788 ± ·018 | *96* | ·673 ± ·038 | — | — | — | — |

The correlation in the English is remarkably close to that in the Thebans, and considerably greater than that in the Naqadas. In the pair *C* and *U*, the female is the more highly correlated, in the pair *C* and *Q* the male has the advantage in all three series, but there is no marked preponderance in favour of either sex except in Theban *C* and *Q*. Unfortunately there is as yet no published material available for further comparison. In the English, the female is considerably the more highly correlated in *C* and *S*, but in the pair *C* and the product *USQ* the correlation of the sexes is practically equal.

*Correlation of Circumferences.*

The only material available for comparison is Naqada and Theban *Q* and *U*, which are included in Table XV.

TABLE XV.

| Race | *Q* and *S* | | | | *U* and *S* | | | | *U* and *Q* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ♂ | | ♀ | | ♂ | | ♀ | | ♂ | | ♀ | |
| | No. | | No. | | No. | | No. | | No. | | No. | |
| English | *108* | ·666 ± ·036 | *109* | ·581 ± ·043 | *124* | ·804 ± ·021 | *124* | ·827 ± ·019 | *110* | ·720 ± ·031 | *114* | ·615 ± ·039 |
| Naqada | — | — | — | — | — | — | — | — | *84* | ·512 ± ·054 | *115* | ·454 ± ·050 |
| Theban Mummies | — | — | — | — | — | — | — | — | *202* | ·665 ± ·027 | *96* | ·625 ± ·042 |

We again notice that English and Thebans are very much alike, this time in regard to the correlation of *U* and *Q*, both having a considerably higher correlation than the Naqadas; in all three series, the female has the higher correlation for this pair of characters. In English, for the pair *S* and *U*, the female correlation preponderates; for *S* and *Q*, the male, just as we found in the pairs *C* and *U* and *C* and *Q*.

*Orbital, Facial and Palatal Measurements.*

Only the Naqada results are available for comparison. In our series the marked difference between the sexes in the correlation of height and breadth of orbit will be noted: in the left orbit, the correlation is more than three times as great, in the right orbit about twice as great, in the males as in the females. The nose, palate and face correlations are small in both sexes, and their probable errors are comparatively large.

In these respects the English differ very markedly from the Naqadas. In the latter, the correlation of height and breadth of orbit is much the same for both eyes and for both sexes, and the palatal and facial correlations are considerable in

females. The difference may be partly due to the different methods of measuring the English and Naqada orbit and palate, but in nasal and facial correlations also, where the methods adopted were the same, there is a marked contrast between the two races.

*Index Correlations.*

The following Table shows how the chief index characters are associated with each other in the two series, English and Naqada.

TABLE XVI.

| Character | English | | Naqadas | |
|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ |
| Chamaecephaly | Leptorrhiny<br>*L.* Hypsiconchy<br>*R.* Hypsiconchy<br>Brachystaphyly | Platyrrhiny<br>Hypsiconchy*<br>Chamaeconchy<br>Brachystaphyly | Platyrrhiny<br>Chamaeconchy<br>Chamaeconchy<br>Leptostaphyly | Platyrrhiny<br>Hypsiconchy†<br>Hypsiconchy†<br>Brachystaphyly* |
| Brachycephaly | Platyrrhiny<br>*L.* Chamaeconchy<br>*R.* Chamaeconchy<br>Leptostaphyly | Leptorrhiny<br>Hypsiconchy†<br>Chamaeconchy†<br>Brachystaphyly* | Leptorrhiny<br>Hypsiconchy<br>Hypsiconchy<br>Brachystaphyly | Leptorrhiny*<br>Chamaeconchy*<br>Chamaeconchy*<br>Brachystaphyly |
| Platyrrhiny | *L.* Chamaeconchy<br>*R.* Chamaeconchy<br>Brachystaphyly* | Chamaeconchy<br>Chamaeconchy<br>Leptostaphyly† | Chamaeconchy<br>Chamaeconchy<br>Leptostaphyly | Chamaeconchy<br>Chamaeconchy<br>Brachystaphyly* |
| Brachystaphyly | *L.* Chamaeconchy<br>*R.* Chamaeconchy | Chamaeconchy*<br>Chamaeconchy | Hypsiconchy<br>Hypsiconchy | Hypsiconchy<br>Hypsiconchy |

*L* and *R* denote left and right orbit.

The comparatively high degree of association of platyrrhiny with chamaeconchy in both sexes is a marked feature in both races; so also is the very low correlation between the orbital indices and chamaecephaly and brachycephaly in the female of both races‡.

*Cephalic Indices and L, B and H.*

Table XVII below shows the correlation of the cephalic indices, and the correlation of these indices with length, breadth and height, in English, French

* Correlation very small, or almost insensible.

† Correlation insensible.

‡ In the above Table I have corrected one or two slips in C. D. Fawcett's memoir; e.g., p. 460, she states that in the male Naqada chamaecephaly is associated with *brachystaphyline* characters and the little association in the female is with *leptostaphyline* characters. A glance at her Table on p. 455 shows that brachystaphyline and leptostaphyline have here got interchanged. p. 462 (*a*), brachycephaly as the table shows is associated with *chamaecranial* and not *hypsicranial* characters as inadvertently mis-read. Finally in (*b*) on the same page *platycranial* in line 2 of the paragraph must be interchanged with *stenocranial* in line 3.

and Naqadas; also the spurious correlation where it exists. The coefficients have been calculated by the formulae given in K. Pearson's paper on Spurious Correlation*: to test the results obtained by the formulae, I worked out the coefficients in three cases directly from the actual numerical values of the characters in the same way as I calculated the coefficients shown in Table X, i.e. by summing the products of the actual pairs of values. The results compare as follows:—

| Correlated pair | Coefficient by formulae | Coefficient by products |
|---|---|---|
| $B/L$ and $H/L$ ♂ (114 pairs) | ·439 ± ·051 | ·436 ± ·051 |
| $B/L$ and $H/L$ ♀ (108 pairs) | ·391 ± ·055 | ·399 ± ·055 |
| $B/L$ and $H$ ♂ (114 pairs) | ·024 ± ·063 | ·021 ± ·063 |

The results obtained by the formulae and from the actual numerical values will be seen to agree very closely, and confirm C. D. Fawcett's conclusion† that it seems unnecessary in future to incur the labour of deducing the coefficients directly from the measurements.

Turning now to the Table, we observe that the spurious correlation between any of the pairs of characters is remarkably alike in both sexes and in all three series‡. In our series it is greater than the gross correlation in nine cases, practically equal in four, and in only one is it significantly less; we may therefore conclude, as C. D. Fawcett did from the Naqada and French data§, that "organic correlation between $L$, $B$ and $H$ often tends to reduce the result considerably below the value it would have if the lengths, breadths and heights had been selected from the records in random triplets, i.e. below the spurious correlation." Some further conclusions may be drawn:

(*a*) Dealing with the gross correlation, we see that in English, Altbayerisch, French and Naqadas, if an individual tends to brachycephaly, he will also tend to hypsicephaly.

(*b*) In our series, the correlation between the indices and the lengths which they do not involve is very low for both sexes, and this is true, though not quite to the same degree, of French and Naqadas.

* *R. S. Proc.* Vol. 60, p. 493. Pearson's general formulae are easily adapted to the particular cases met with in the investigation.

† *Loc. cit.* p. 461. C. D. Fawcett's Table is clearly based on the French measurements and not on the Naqada as stated in the text.

‡ The only other calculation known to me, of spurious correlation in the skull, is that given by K. Pearson, *R. S. Proc.* Vol. 60, p. 495, for $B/L$ and $H/L$ in 100 Altbayerisch ♂ skulls, viz. ·4008; but this should be ·4347, which is more in accordance with the values in our Table. I may note the following further arithmetical corrections required in that paper: p. 495, read $r_{21}$ = ·19795 for $r_{21}$ = ·1243 and $\rho_0$ = ·4347 for ·4008; p. 496, read $\rho_0$ = ·4613 for $\rho_0$ = ·4557; p. 497, read $\rho_0$ = ·4333 for $\rho_0$ = ·3904.

§ *Loc. cit.* p. 461.

## TABLE XVII.

*Correlation of English Cranial Characters, and Comparison with other Races.*

| Pairs of characters | English Series | | | | | |
|---|---|---|---|---|---|---|
| | ♂ | | | ♀ | | |
| | No. | Gross | Spurious | No. | Gross | Spurious |
| *B/L* and *H/L* | 114 | ·439 ± ·051 | ·419 ± ·052 | 108 | ·391 ± ·055 | ·494 ± ·049 |
| *B/H* and *L/H* | 114 | ·580 ± ·042 | ·598 ± ·041 | 108 | ·581 ± ·043 | ·559 ± ·044 |
| *H/B* and *L/B* | 114 | ·478 ± ·049 | ·478 ± ·049 | 108 | ·522 ± ·047 | ·444 ± ·052 |
| *B/L* and *H* | 114 | ·024 ± ·063 | — | 108 | − ·144 ± ·063 | — |
| *B/H* and *L* | 114 | − ·048 ± ·063 | — | 108 | − ·086 ± ·064 | — |
| *H/L* and *B* | 114 | ·072 ± ·063 | — | 108 | − ·061 ± ·064 | — |
| *B/L* and *L* | 131 | − ·547 ± ·041 | − ·658 ± ·033 | 130 | − ·541 ± ·042 | − ·689 ± ·031 |
| *H/L* and *L* | 120 | − ·477 ± ·047 | − ·615 ± ·038 | 117 | − ·475 ± ·048 | − ·674 ± ·034 |
| *B/L* and *B* | 131 | ·682 ± ·032 | ·753 ± ·026 | 130 | ·599 ± ·038 | ·725 ± ·028 |
| *H/L* and *H* | 120 | ·728 ± ·029 | ·786 ± ·023 | 117 | ·596 ± ·040 | ·739 ± ·028 |
| | French Series * | | | | | |
| *B/L* and *H/L* | 860 | ·489 ± ·018 | ·464 ± ·019 | 340 | ·576 ± ·024 | ·477 ± ·028 |
| *B/H* and *L/H* | 860 | ·419 ± ·020 | ·527 ± ·017 | 340 | ·417 ± ·030 | ·541 ± ·026 |
| *H/B* and *L/B* | 860 | ·586 ± ·016 | ·508 ± ·018 | 340 | ·503 ± ·027 | ·482 ± ·028 |
| *B/L* and *H* | 860 | − ·040 ± ·024 | — | 340 | ·068 ± ·036 | — |
| *B/H* and *L* | 860 | − ·170 ± ·023 | — | 340 | − ·143 ± ·036 | — |
| *H/L* and *B* | 860 | ·126 ± ·023 | — | 340 | ·211 ± ·035 | — |
| *B/L* and *L* | 860 | − ·652 ± ·014 | − ·686 ± ·013 | 340 | − ·720 ± ·018 | − ·705 ± ·018 |
| *H/L* and *L* | 860 | − ·548 ± ·017 | − ·677 ± ·013 | 340 | − ·622 ± ·022 | − ·677 ± ·020 |
| *B/L* and *B* | 860 | ·699 ± ·012 | ·727 ± ·011 | 340 | ·729 ± ·017 | ·714 ± ·018 |
| *H/L* and *H* | 860 | ·639 ± ·014 | ·736 ± ·011 | 340 | ·694 ± ·019 | ·736 ± ·017 |
| | Naqada Series † | | | | | |
| *B/L* and *H/L* | 130 | ·284 ± ·054 | ·432 ± ·048 | 166 | ·371 ± ·046 | ·438 ± ·043 |
| *B/H* and *L/H* | 131 | ·595 ± ·038 | ·603 ± ·037 | 163 | ·527 ± ·039 | ·552 ± ·037 |
| *H/B* and *L/B* | 131 | ·601 ± ·037 | ·459 ± ·046 | 163 | ·594 ± ·035 | ·508 ± ·040 |
| *B/L* and *H* | 130 | − ·176 ± ·056 | — | 169 | − ·111 ± ·053 | — |
| *B/H* and *L* | 131 | − ·184 ± ·057 | — | 163 | − ·115 ± ·053 | — |
| *H/L* and *B* | 131 | − ·001 ± ·059 | — | 166 | − ·003 ± ·054 | — |
| *B/L* and *L* | 130 | − ·551 ± ·041 | − ·694 ± ·031 | 169 | − ·613 ± ·032 | − ·673 ± ·028 |
| *H/L* and *L* | 131 | − ·323 ± ·052 | − ·623 ± ·036 | 166 | − ·514 ± ·039 | − ·651 ± ·031 |
| *B/L* and *B* | 130 | ·594 ± ·038 | ·720 ± ·028 | 169 | ·695 ± ·028 | ·740 ± ·024 |
| *H/L* and *H* | 131 | ·660 ± ·033 | ·782 ± ·023 | 166 | ·677 ± ·029 | ·759 ± ·023 |

* Paris Catacomb Crania. The values were deduced from copies of Broca's MS. measurements sent by the kindness of M. Manouvrier to K. Pearson (C. D. Fawcett, *loc. cit.* p. 456).

† C. D. Fawcett, *loc. cit.* p. 456. A few slight slips in the arithmetic have been corrected, and the whole series of results now is in better accordance.

Finally, looking at the correlation between the indices and the absolute lengths which they involve, we observe that the following statements hold with regard to all three series, English, French and Naqadas.

(*c*) Dolichocephaly and chamaecephaly are associated with macrocranial characters.

(*d*) Brachycephaly is associated with platycranial characters.

(*e*) Hypsicephaly is associated with hypsicranial characters.

In (*c*), (*d*) and (*e*), the association is due entirely to the spurious correlation.

The technical descriptive terms are used above in an intra-racial sense. As usual, dolichocephalic, chamaecephalic, stenocephalic denote crania having their $B/L$, $H/L$ and $B/H$ indices below, brachycephalic, hypsicephalic, platycephalic denote crania having these indices above, the racial mean. Brachycranial, stenocranial and chamaecranial are used to denote individuals whose $L$, $B$ and $H$ are below, macrocranial, platycranial and hypsicranial denote individuals in which these measurements are above, the racial mean*. These terms cannot be used in an inter-racial sense until we have determined inter-racial means, that is, means of racial means, and little progress has as yet been made with such determinations. The only instances of which I am aware are to be found in *Biometrika*, Vol. II. p. 353, where Dr Alice Lee has found a scientific classification of cephalic index and nasal index in living races, based on the means of 51 races.

### (12) *General Conclusions.*

I look upon this memoir as in the first place contributing new material in a reduced form to the collection of biometric data for man which is slowly being formed. Only when that collection is far more complete will it be possible to state general conclusions applying to the whole field of craniology. I venture to think that the chief aim of craniologists at present should be to table the means, standard deviations and correlations of further long series of skulls. When such tables have been formed for 40 or 50 long series we shall have far more light not only on intra-racial but on inter-racial problems.

Admitting that this is primarily a contribution to such a biometric description of mankind, we are still I think justified in drawing one or two general conclusions, partly with reference to the English cranium itself and partly with reference to its relation to other groups or series.

In the first place it will be noted that our material comes from a single centre, and it may be said not to be a fair sample of the English skull in general. The only reply that can be made to this is that whether judged by the biometric constants or by a careful appreciation of the material as a whole, the series appears to be homogeneous, and very different from German, French or other continental

* See Schmidt, *Anthropologische Methoden*, p. 296.

series with which we are acquainted. Further it is closely in accord with a second series from an entirely different burial spot on the opposite side of the city of London. We can therefore assert that in the 17th century there certainly did exist a remarkable type in the city of London, which is unlike any continental type with which we are familiar, and which is markedly different from what some authorities have supposed the English type to have been or at least now to be. It is quite true that isolated English skulls are to be found in museums which provide measurements not wholly in agreement with those of our two series*, but such skulls have often been selected as "fine" specimens, and the total material available in no way approaches the long series with which we are dealing. Until another long series or two of English skulls are measured, and are shown to differ sensibly from our two series, we may I think fairly assume that our results describe the English skull, or at least that of the typical citizen of London, in the only series that at present have reasonable weight. Indeed a proof that we are not dealing with anything *very* local and exceptional may be obtained by the comparison of the biometric constants of our Whitechapel series with those for the whole of Sir William Turner's Scottish series which I have calculated, correcting a few arithmetical slips in his Table XVI, and placed for comparison in Table XVIII below.

The most marked differences are here in the length, breadth and resulting cephalic index, as well as in the orbital measurements. The latter, however, differ so from observer to observer that they can hardly be used as a criterion. The general correspondence is apparent and considering the heterogeneity of the Scottish series, remarkable.

When we turn to our series we see that it is markedly differentiated not only from existing continental types but from earlier racial types in Britain by its extreme length. This extreme length seems closely associated with protuberance of the occiput or even bathrocephalic abnormality. In the first gathering of the Whitechapel crania, which covered Nos. 7037—7127 of our Tables there was a distinct attempt to collect skulls of anatomical interest†, but afterwards the whole material was brought to University College. Of course if any large number of the crania had been stolen between the two removals, this would have emphasised the proportion of remarkable skulls in the series. But we do not believe that any sensible effect was produced in this way; and we hold this for the simple reason that in the crania from Moorfields, there is at least an equally large proportion of abnormal or remarkable crania; the latter collection was made on one occasion and embraced we believe the complete series of excavated skulls. Indeed bathro-

* Modern English skulls essentially of the present type are indeed to be found in museums, for example the skull No. 565 of the Oxford Collection, which the cataloguer finds "remarkable for its length." Did he compare it with any collection of English crania, or only with those of the crania of other races in the museum? Professor Pearson is in part responsible for the inferences drawn in this concluding section.

† This fact will explain the extension of the "Remarks" peculiar to these numbers in the Tables of measurements.

cephaly and protuberance of occiput are, if anything, more marked in the Moorfields than in the Whitechapel crania*. The great average length, the comparative narrowness and the resulting degree of dolichocephaly, are of course not the only distinguishing marks of the Whitechapel crania, but they are those which strike the most casual observer. They lead us at once to ask: Where can we find anything which in the least corresponds to these English characters? The answer appears to be only in the Long Barrow crania of this and other

## TABLE XVIII.

*Comparison of Scottish and Whitechapel Skulls.*

| Character | ♂ | | | | | | ♀ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scottish | | | Whitechapel | | | Scottish | | | Whitechapel | | |
| | Mean | S. D. | C. of V. | Mean | S. D. | C. of V. | Mean | S. D. | C. of V. | Mean | S. D. | C. of V. |
| *C* ... ... | 1496 | — | — | 1477 | — | — | 1323 | — | — | 1300 | — | — |
| *L* ... ... | 186·8 | 7·42 | 3·97 | 189·1 | 6·27 | 3·31 | 178·9 | 7·15 | 4·00 | 180·4 | 6·22 | 3·45 |
| *B* ... ... | 144·3 | 5·94 | 4·11 | 140·7 | 5·28 | 3·75 | 137·8 | 5·11 | 3·71 | 134·7 | 4·77 | 3·54 |
| *H* ... ... | 132·4 | 6·10 | 4·60 | 132·0 | 5·56 | 4·21 | 126·2 | 5·02 | 3·98 | 124·6 | 4·93 | 3·96 |
| *LB* ... | 101·4 | — | — | 101·6 | — | — | 95·3 | — | — | 95·3 | — | — |
| *U* ... ... | 531·2 | — | — | 524·2 | — | — | 506·7 | — | — | 503·8 | — | — |
| *G'H* ... | 71·7 | — | — | 70·2 | — | — | 66·9 | — | — | 65·9 | — | — |
| *J* ... ... | 132·4 | — | — | 130·0 | — | — | 121·6 | — | — | 120·3 | — | — |
| *NH* ... | 52·4 | 3·21 | 6·12 | 51·2 | 2·60 | 5·08 | 49·9 | 2·93 | 5·86 | 48·7 | 2·70 | 5·55 |
| *NB* ... | 23·2 | 1·78 | 7·69 | 24·3 | 2·16 | 8·89 | 22·0 | 1·85 | 8·41 | 23·2 | 1·64 | 7·06 |
| $O_1$ ... ... | 39·1† | 1·86 | 4·76 | 43·0‡ | L 1·81<br>R 2·02 | 4·20<br>4·69 | 37·4† | 1·61 | 4·31 | 41·1‡ | L 1·45<br>R 1·64 | 3·53<br>4·00 |
| $O_2$ ... ... | 34·1† | 2·58 | 7·57 | 33·4‡ | L 1·88<br>R 2·22 | 5·61<br>6·65 | 33·4† | 2·58 | 7·71 | 33·7‡ | L 1·45<br>R 1·51 | 4·31<br>4·47 |
| *GL* ... | 96·1 | — | — | 95·9 | — | — | 91·2 | — | — | 90·4 | — | — |
| 100*GL*/*LB* | 94·9 | — | — | 94·4 | — | — | 94·9 | — | — | 94·8 | — | — |
| 100*B*/*L* ... | 77·3 | — | — | 74·3 | — | — | 77·1 | — | — | 74·7 | — | — |
| 100*H*/*L* ... | 70·9 | — | — | 70·0 | — | — | 70·5 | — | — | 69·1 | — | — |
| 100*NB*/*NH* | 44·5 | 3·80 | 8·54§ | 47·6 | 4·58 | 9·64 | 44·1 | 4·64 | 10·53§ | 47·8 | 3·90 | 8·16 |
| 100$O_2$/$O_1$ ... | 87·3 | 5·49 | 6·29§ | 77·8‡ | L 3·78<br>R 4·66 | 4·86<br>6·00 | 89·4 | 6·85 | 7·66§ | 82·1‡ | L 4·23<br>R 4·33 | 5·18<br>5·25 |
| 100*G'H*/*J* .. | 54·4 | — | — | 53·8 | — | — | 55·1 | — | — | 54·8 | — | — |

* Special prominence will be given to these features in the plates to the memoir on the Moorfields crania.

† Apparently only one orbit was measured, and which not stated; $O_1$ was measured from the dacryon, and hence is not properly comparable with our $O_1$.

‡ Average of our *L* and *R*.

§ With reference to these indexes, Sir William Turner writes, p. 603: "*Orbital Index*....My obser- "vations on the orbital index in the skulls of numerous races have satisfied me that it presents a great "range of variation in the same race, and that it possesses only a secondary value as a race character. "*Nasal Index*. The relation between the height of the nose, measured from the nasion to the lower "border of the apertura pyriformis, and the greatest width of that aperture, constitutes one of the most "important anthropological characters of the face."

It will be observed, however, that the variability, as measured by the coefficient of variation, of the nasal index is much greater, both in males and females, than that of the orbital index, and this is true of the Whitechapel and Naqada series as well as of the Scottish.

countries. They agree with nothing else on the continent with which we are acquainted. Our crania do not accord with Anglo-Saxon, with Romano-British or with Round Barrow British, but are in general appearance and biometric constants remarkably close to the Long Barrow British. I have endeavoured to indicate this in the accompanying Table:

TABLE XIX.

*Comparison of Means of Modern English and Long Barrow Crania.*

| Character | Whitechapel Crania 43 to 137 ♂ s | Moorfields Crania 19 to 46 ♂ s | Long Barrow Crania, Oxford, measured by E. Schuster* 11 to 17 ♂ s | Long Barrow Crania, Cambridge, measured by A. Macalister† 37 to 54 ♂ s | Reihengräber Schädel‡ 6 to 16 ♂ s | Swedish Crania, stone age, Retzius‡ 13 to 25 ♂ s |
|---|---|---|---|---|---|---|
| *C* ... | 1477 | 1473 | — | — | 1455 | 1498 |
| *L* ... | 189 | 189 | 190 | 196 | 193 | 187·5 |
| *B* ... | 141 | 143 | 140 | 140 | 142 | 142 |
| *B'* ... | 98 | 98 | 99 | 98 | 98 | 98 |
| *H* ... | 132 | 130 | 135 | 137 | 140·5 | 138 |
| *U* ... | 524 | 527 | 533 | 538 | 534 | 527 |
| *S* ... | 377 | 379 | 384 | — | 385 | 379 |
| *Q* ... | 308 | 305 | 320 | 314 | — | 324 |
| *G'H* ... | 70 | 68 | 70 | — | 69 | 69·5 |
| *J* ... | 130 | 129§ | 134 | — | 132 | 132 |
| $100G'H/J$... | 54 | 52‖ | 52 | — | 52 | 53 |
| $100B/L$ ... | 74 | 75 | 74 | 71 | 74 | 76 |
| $100H/L$ ... | 70 | 68 | 71 | 70 | 73 | 74 |

An examination of these characters seems to warrant the statement, which is amply borne out by the method of 'appreciation,' that the crania of Londoners of not more than 200 to 300 years ago indicate that a very large proportion of the inhabitants of London at that time were of a type which can only be described as approaching that of Long Barrow men. If they were so then, the type is certainly not extinct now, and we may even venture to describe the ancestor of the genuine cockney as a Long Barrow man. Whether the Long Barrow Man has remained a denizen of London through all the invasions to which the country has been subject, or whether a process of selection has gone on, the London environment being suited only to the Long Barrow type, we cannot yet say, but when long series of modern English skulls from other places are dealt with, we shall no doubt see our way further. Meanwhile the only general conclusion which we can reach

* Unpublished measurements for which we have heartily to thank Mr E. Schuster.

† We must cordially thank Professor A. Macalister for sending us copies of his measurements on these crania. They originally belonged to Thurnam (see his paper: *On the two Principal Forms of Ancient British and Gaulish Skulls*, 1865; Table I), but Thurnam's measurements are doubtful and his averages are incorrect.

‡ Deduced by K. Pearson from measurements given in the German Anthropological Catalogue, and in G. Retzius, *Crania Suecica Antiqua*, Tafel I., respectively.

§ Mean of 7 crania only. ‖ Mean of 6 crania only.

is the simple but startling one, that the London City crania—from Whitechapel to Moorfields—are far more closely allied to the Long Barrow type than to any other. We do not see how to avoid this conclusion, it is hardly needful to say that, if verified, its importance from both the craniological and historical standpoint can hardly be exaggerated. It would mean that at any rate a section—probably a large section—of the English population are not Anglo-Saxon, nor Scandinavian, nor even Celtic, but belong to a still earlier race.

Regarding our present material in conjunction with the other series dealt with for comparative purposes, we must draw very similar conclusions to those already propounded in C. D. Fawcett's memoir, i.e.:

The correlations between cranial characters are generally low and vary considerably from race to race. All generalisation from individual series—or, as it often happens, from individual skulls—to wide craniological laws seems to be idle. The present great need of craniology is the accumulation of intra-racial biometric constants with a view to the ultimate calculation of inter-racial means, standard deviations and correlations. These will provide the only possible basis for a correct theory of race in man, as well as for a really scientific craniological terminology.

## *Appendix of Tables of Measurements.*

The measurements are tabled in nearly the same manner as in the case of the Naqada crania. The notation used is identical:

Thus cr. = *cranium*, i.e. skull + mandible; cal. = *calvarium* = skull − mandible; f. stands for face. Thus cal. − f. = calvarium − face bones; dome = the roof of the skull only (*Schädeldach*). These terms are in accordance with those used in C. D. Fawcett's memoir, and are close to the terms adopted in Germany. Probably the English use of cranium for what is above called calvarium, and of calvarium for "dome," would have been better. But it did not seem desirable to change from the notation already adopted in *Biometrika*.

In calculating the constants involving length of skull, Nos 186, 7042 and 7059 were excluded on account of their extreme bathrocephaly.

In the age statements, which are of course only appreciations, *child* = an individual less than 15 years, *adolesc.* 15—20, *y. ad.* 20—30, *ad.* 30—50, and *old* above 50.

During the past winter Professors Thane and Pearson went through the whole series of skulls again and the former not only again considered questions of sex and probable age, but supplied the anatomical notes which are embodied in the accompanying "Remarks" on the crania. I have thus not only to thank him for allowing me to work on his splendid material, but also for the time he has spent on a lengthy anatomical examination of the whole series. Added to these matters all biometric workers at University College have had experience of his ready aid and advice at many stages of their investigations.

## *Addenda.*

The following capacities omitted by oversight should be entered in the Tables: W. 7037, C = 1320 and W. 7041, C = 1650.

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The Editors have to acknowledge a grant from the Publication Fund of the Royal Society towards the printing of the 50 plates accompanying this paper. The blocks for these were paid for out of a grant from the Drapers' Company's Donation to the Department of Applied Mathematics in University College, London, as already stated on p. 215.

| | | | Lengths | | | | | | | | Circumferences | | | Face | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Series No. | Sex | *C* | *F* | *L'* | *L* | *B* | *B'* | *H* | *OH* | *LB* | *U* | *S* | *Q* | *G'H* | *GB* | *J* | *NH* | *NB* | $O_1$ *L* | $O_1$ *R* | *O* *L* |
| 1 | ♂ | 1615 | 186 | 188 | 188 | 146 | 99 | 136 | 120 | 105 | 525 | 381 | 325 | — | — | — | 50 | — | 43 | — | 33 |
| 2 | ♂ | — | 194 | — | 196 | 141 | 103 | 139 | 112 *h* | 112 | — | 376 | — | 75 | — | — | 56·5 | 25·5 | 44 | 45 | 33·5 |
| 3 | ♂? | — | 187 | 187 | 187 | 141 | 97 | — | 114 | — | 525 | 374 | 311 | 69 | 92 | 127 | 49 | 23 | 41·5 | 40·5 | 30·5 |
| 4 | ♂ | — | 197 | — | 198 | 139 | 95 | — | — | — | 543 | 400 | — | 72 | — | — | 52 | 23 | 42 | 40·5 | 33·5 |
| 5 | ♀ | — | 185 | — | 187 | 140 | 97 | 127 | 111 *h* | 100 | 522 | 370 | 296 | — | — | — | — | — | — | — | — |
| 6 | ♀? | — | 180 | — | 181 | — | 88 | 125 | 110 *h* | 97 | — | 361 | — | 66·5 | 89 | — | 47·5 | 21 | 42 | 42 | 34·5 |
| 7 | ♂ | 1435 | 188 | 191 | 191 | 140 | 99 | 140 | 114 | 108 | 522 | 370 | 302 | 70·5 | 88 | — | 50 | 21 | 44 | 45·5 | 33·5 |
| 9 | ♂ | — | 198 | — | 200 | 136? | 97 | 134 | 117 *h* | 104 | 545 | 395 | 315 | — | — | — | — | — | — | — | — |
| 10 | ♀ | 1280 | 186 | 184 | 184 | 127 | 84 | 122 | 109 | 95 | 505 | 381 | 287 | 62·5 | 76 | — | 47·5 | 20 | 36 | 35·5 | 34 |
| 11 | ♂ | 1595 | 187 | 187 | 187 | 145 | 102 | 140 | 120 | 104 | 526 | 381 | 322 | 67? | 88 | 132 | 48·5 | 22·5 | 40·5 | 41 | 30·5 |
| 12 | ♂ | 1595 | 193 | — | 198 | 141 | 103 | 138 | 119 *h* | 113 | 537 | 385 | 315 | — | — | — | — | — | — | — | — |
| 13 | ♂ | — | 184 | — | 188 | 142 | 102 | 128 | 112 *h* | 102 | 528 | 364 | 306 | — | — | — | — | — | — | — | — |
| 14 | ♀ | 1220 | 172 | — | 173 | 130 | 90 | 129 | 109 *h* | 93 | 484 | 356 | 291 | — | — | — | — | — | — | — | — |
| 15 | ♀ | 1235 | 168 | — | 168 | 136 | 94 | 127 | 116 *h* | 96 | 485 | 343 | 309 | — | — | — | — | — | — | — | — |
| 16 | ♀ | 1270 | 186 | 187 | 187 | 127 | 93 | 122 | 107 | 95 | 509 | 372 | 283 | 71·5 | 84 | 120 | 51 | 23 | 42 | 42·5 | 35·5 |
| 17 | ♂ | 1545 | 189 | 189 | 190 | 131 | 89 | 132 | 116 | 102 | 513 | 385 | 303 | 72 | — | — | 52 | 23 | 40 | — | 32·5 |
| 18 | ♀ | 1345 | 175 | 174 | 175 | 139 | 97 | 125 | 108 | 97 | 504 | 352 | 293 | 63 | 91 | 126 | 49 | 22·5 | 40 | 41 | 33 |
| 19 | ♀ | 1160 | 175 | — | 175 | 130 | 92 | 121 | 111 *h* | 91 | 496 | 365 | 295 | — | — | — | — | — | — | — | — |
| 20 | ♀ | — | 177 | 177 | 177 | — | 90 | 119 | 106 | 95 | — | — | 286 | 66 | — | — | 48·5 | — | — | 41 | — |
| 21 | ♀ | — | — | — | — | 136 | 101 | 125 | 103 *h* | 95 | — | — | 293 | — | — | — | — | — | — | — | — |
| 22 | ♂? | 1670 | 189 | — | 190 | 144 | 102 | 135 | 119 *h* | 103 | 533 | 380 | 321 | — | — | — | — | — | — | 44 | — |
| 23 | ♀ | — | 178 | — | 179 | — | 91 | 138 | 118 *h* | 105 | 485 | 365 | 301 | — | — | — | — | — | — | — | — |
| 24 | ♀ | 1230 | 170 | — | 169 | 134 | 97 | 124 | 110 *h* | 93 | 487 | 340 | 295 | — | — | — | — | — | — | — | — |
| 25 | ♂ | 1470 | 187 | 189 | 190 | 142 | 101 | 127 | 109 | 103 | 525 | 368 | 298 | 73·5 | — | — | 52·5 | — | — | 44·5 | — |
| 26 | ♂ | — | 189 | 189 | 190 | 140 | — | 134 | 118 | 102 | 527 | 388 | 309 | — | — | — | 52·5 | — | — | 45 | — |
| 27 | ♀ | 1240 | 176 | — | 177 | 138 | 91 | 128 | 113 *h* | 91 | 495 | 366 | 304 | — | — | — | — | — | — | — | — |
| 28 | ♀ | 1315 | 186 | 186 | 186 | 140 | 97 | 121 | 107 | 93 | 521 | 372* | 299 | 63·5 | 88 | 121 | 46 | 25 | 39 | 40 | 33 |
| 29 | ♀? | — | 188 | — | 190 | 131 | — | 130 | 115 *h* | 103 | 513 | 373 | 293 | — | — | — | — | — | — | — | — |
| 30 | ♀ | 1325? | 177 | — | 176 | 138 | 96 | 125 | 108 *h* | 93 | 505 | 361 | 299 | — | — | — | — | — | — | — | — |
| 31 | ♂ | — | 197 | — | 198 | 144 | 98 | — | 114 *h* | — | 548 | 390 | 310 | — | — | — | — | — | — | — | — |
| 32 | ♂ | — | 183 | — | 184 | 140 | 94 | 133 | 119 *h* | 92 | 518 | 391 | 322 | — | — | — | — | — | — | — | — |
| 33 | ♂ | 1465 | 185 | 186 | 186 | 138 | 106 | 135 | 113 | 105 | 520 | 369 | 305 | 67 | — | — | 48·5 | 25·5 | — | 44 | — |
| 34 | ♀ | — | 178 | — | 177 | 132 | 93 | 124 | 110 *h* | 94 | 495 | 362 | 293 | — | — | — | — | — | — | — | — |
| 35 | ♂ | — | 187 | — | 190 | 139 | 93 | — | 109 *h* | — | 524 | 376 | — | — | — | — | — | — | — | — | — |
| 36 | ♀ | — | 181 | — | 181 | 127 | 88 | — | 105 *h* | — | 497 | — | 280 | — | — | — | — | — | — | — | — |
| 37 | ♂ | — | 182 | — | 184 | — | — | 126 | 110 *h* | 101 | 503 | 364 | 291 | — | — | — | — | — | — | — | — |
| 38 | ♂ | 1365 | 174 | 176 | 176 | 147 | 95 | 126 | 113 | 98 | 509 | 360 | 309 | — | — | — | — | — | — | 43 | — |
| 39 | ♀ | — | 179 | — | 181 | 137 | 93 | 132 | 113 *h* | 100 | 505 | 369 | 308 | — | — | — | — | — | — | — | — |
| 40 | ♀ | — | 169 | — | 169 | 130 | 84 | 120 | 107 *h* | — | 476 | — | 285 | — | — | — | — | — | — | — | — |
| 41 | ♂ | 1415 | 183 | — | 185 | 139 | 97 | 128 | 109 *h* | 97 | 523 | 369 | 303 | — | — | — | — | — | — | — | — |
| 42 | ♀ | — | 171 | 171 | 171 | 135 | 85 | 116 | 102 | 91 | 490 | — | 275 | 63 | 83 | 117 | 47 | 21·5 | 40·5 | 39 | 34 |
| 43 | ♀ | 1400 | 182 | — | 181 | 139 | 92 | 123 | 113 *h* | 89 | 516 | 387 | 303 | — | — | — | — | — | — | — | — |
| 44 | ♀ | 1100 | 177 | — | 177 | 131 | 95 | 118 | 102 *h* | 94 | 493 | 342 | 281 | — | — | — | — | — | — | — | — |
| 45 | ♂ | 1495 | 186 | 189 | 190 | 141 | 100 | 136 | 114 | 100 | 521 | 382 | 307 | 68 | 89 | 135 | 53 | 24 | 44·5 | 45·5 | 33·5 |
| 46 | ♂ | — | 182 | — | 184 | 137 | 92 | 131 | 112 *h* | 99 | 505 | 362 | — | 65·5 | 89 | — | 49·5 | 23·5 | 40·5 | 41 | 33·5 |
| 47 | ♂ | 1455 | 182 | — | 186 | 141 | 91 | 126 | 112 *h* | 99 | 512 | 370 | 307 | — | — | — | — | — | — | — | — |
| 49 | ♀ | 1275 | 173 | — | 172 | 134 | 91 | 122 | 106 *h* | 92 | 491 | 359 | 287 | — | — | — | — | — | — | — | — |
| 50 | ♀ | 1385 | 177 | 175 | 175 | 135 | 93 | — | 112 | — | 499 | 371 | 302 | 60 | 83 | — | 46 | 22 | 39 | — | 32·5 |
| 51 | ♀ | 1405 | 191 | — | 192 | 136 | 101 | 126 | 115 *h* | 101 | 528 | 385 | 312 | — | — | — | — | — | — | — | — |
| 52 | ♀ | 1460 | 187 | 186 | 188 | 138 | 95 | 139 | 117 | 104 | 516 | 372 | 307 | 71 | — | — | 47 | 23·5 | 42 | — | 35 |
| 53 | ♂ | 1315 | 187 | 187 | 188 | 132 | 106 | 133 | 114 | 107 | 513 | 369 | 300 | 70·5 | — | — | 51·5 | 24·5 | 47 | 47 | 35·5 |
| 54 | ♂ | — | 186 | — | 186 | 140 | 92 | 139 | 117 *h* | 99 | 525 | 388 | — | — | — | — | — | — | — | — | — |
| 55 | ♀ | — | 178 | — | 180 | 132 | 95 | 129 | 113 *h* | 97 | 496 | 361 | 291 | — | — | — | — | — | — | — | — |

# SUREMENTS OF SEVENTEENTH CENTURY ENGLISH CRANIA.

| | | $O_2$ | | Palate | | Indices | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L | $O_1$ R | L | R | $G_1$ | $G_2$ | B/L′ | H/L′ | B/L | H/L* | B/H | G′H/GB | NB/NH | $O_2/O_1$ L | $O_2/O_1$ R | $G_2/G_1$ | GL | N ∠ | A ∠ | B ∠ |
| | — | 33 | — | 51 | 35 | 77·7 | 72·3 | 77·7 | 72·3 | 107·4 | — | — | 76·7 | — | 68·6 | 96 | — | — | — |
| | 45 | 33·5 | 34 | 52 | 45 | — | — | 71·9 | 70·9 | 101·4 | — | 45·1 | 76·1 | 75·6 | 86·5 | 102 | 62°·5 | 77°·5 | 40° |
| 5 | 40·5 | 30·5 | 32 | — | 35·5 | 75·4 | — | 75·4 | — | — | 75 | 46·9 | 73·5 | 79 | — | — | — | — | — |
| | 40·5 | 33·5 | 33·5 | 43 | 35 | — | — | 70·2 | — | — | — | 44·2 | 79·8 | 82·7 | 81·4 | — | — | — | — |
| | — | — | — | — | — | — | — | 74·9 | 67·9 | 110·2 | — | — | — | — | — | — | — | — | — |
| | 42 | 34·5 | 33·5 | 45·5 | 34·5 | — | — | — | 69·1 | — | 74·7 | 44·2 | 82·1 | 79·8 | 75·8 | 92 | 65° | 73°·5 | 41°·5 |
| | 45·5 | 33·5 | 33·5 | 44·5 | 32·5 | 73·3 | 73·3 | 73·3 | 73·3 | 100 | 80·1 | 42 | 76·1 | 73·6 | 73 | 94·5 | 59°·5 | 80°·5 | 40° |
| | — | — | — | — | — | — | — | 68 | 67 | 101·5 | — | — | — | — | — | — | — | — | — |
| | 35·5 | 34 | 33·5 | 43 | 33·5 | 69 | 66·3 | 69 | 66·3 | 104 | 82·2 | 42·1 | 94·4 | 94·4 | 77·9 | 89 | 65° | 75°·5 | 39°·5 |
| 5 | 41 | 30·5 | 29·5 | 51 | 32 | 77·5 | 74·9 | 77·5 | 74·9 | 103·6 | 76·1 | 46·4 | 75·3 | 71·9 | 62·7 | 94·5 | 62°·5 | 78° | 39°·5 |
| | — | — | — | — | — | — | — | 71·2 | 69·7 | 102·1 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 75·5 | 68·1 | 111 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 75·1 | 74·6 | 100·8 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 80·9 | 75·6 | 107·1 | — | — | — | — | — | — | — | — | — |
| | 42·5 | 35·5 | 34·5 | 45 | 34 | 67·9 | 65·2 | 67·9 | 65·2 | 104 | 85·1 | 45·1 | 84·5 | 81·2 | 75·6 | 90·5 | 64° | 71° | 45° |
| | — | 32·5 | — | 46 | 37·5 | 69·3 | 69·8 | 68·9 | 69·5 | 99·2 | — | 44·2 | 81·2 | — | 81·5 | 95 | 63°·5 | 74° | 42°·5 |
| | 41 | 33 | 32·5 | 47·5 | 32 | 79·9 | 71·8 | 79·4 | 71·4 | 111·2 | 69·2 | 45·9 | 82·5 | 79·3 | 67·4 | 93 | 67° | 74° | 39° |
| | — | — | — | — | — | — | — | 74·3 | 69·1 | 107·4 | — | — | — | — | — | — | — | — | — |
| | 41 | — | 32 | 45 | — | — | 67·2 | — | 67·2 | — | — | — | — | 78 | — | 92 | 67° | 72° | 41° |
| | — | — | — | — | — | — | — | — | — | 108·8 | — | — | — | — | — | — | — | — | — |
| | 44 | — | 34·5 | — | — | — | — | 75·8 | 71 | 106·7 | — | — | — | 78·4 | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 77·1 | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 79·3 | 73·4 | 108·1 | — | — | — | — | — | — | — | — | — |
| | 44·5 | — | 34·5 | — | — | 75·1 | 67·2 | 74·7 | 66·8 | 111·8 | — | — | — | 77·5 | — | 98 | 65° | 72° | 43° |
| | 45 | — | 30 | — | — | 74·1 | 70·9 | 73·7 | 70·5 | 104·5 | — | — | — | 66·7 | — | — | — | — | — |
| | — | — | — | — | — | — | — | 78 | 72·3 | 107·9 | — | — | — | — | — | — | — | — | — |
| | 40 | 33 | 33·5 | 45·5 | 32 | 75·3 | 65 | 75·3 | 65 | 115·7 | 72·2 | 54·3 | 84·6 | 83·7 | 70·3 | 93 | 70° | 70° | 40° |
| | — | — | — | — | — | — | — | 68·9 | 68·4 | 100·8 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 78·4 | 71 | 110·4 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 72·7 | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 76·1 | 72·3 | 105·3 | — | — | — | — | — | — | — | — | — |
| | 44 | — | 31·5 | 52 | — | 74·2 | 72·6 | 74·2 | 72·6 | 102·2 | — | 52·6 | — | 71·6 | — | 102 | 68°·5 | 73°·5 | 38° |
| | — | — | — | — | — | — | — | 74·6 | 70·1 | 106·5 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 73·2 | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 70·2 | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 68·5 | — | — | — | — | — | — | — | — | — | — |
| | 43 | — | 35 | — | — | 83·5 | 71·6 | 83·5 | 71·6 | 116·7 | — | — | — | 81·4 | — | — | — | — | — |
| | — | — | — | — | — | — | — | 75·7 | 72·9 | 103·8 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 76·9 | 71 | 108·3 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 75·1 | 69·2 | 108·6 | — | — | — | — | — | — | — | — | — |
| 5 | 39 | 34 | 34·5 | 40 | 33·5 | 78·9 | 67·8 | 78·9 | 67·8 | 116·4 | 75·9 | 45·7 | 83·9 | 88·5 | 83·7 | 84 | 63° | 75° | 42° |
| | — | — | — | — | — | — | — | 76·8 | 68 | 113 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 74 | 66·7 | 111 | — | — | — | — | — | — | — | — | — |
| 5 | 45·5 | 33·5 | 33·5 | — | 40? | 74·6 | 72 | 74·2 | 71·6 | 103·7 | 76·4 | 45·3 | 75·3 | 73·6 | — | 96 | 66°·5 | 73° | 40°·5 |
| | 41 | 33·5 | 34 | 46 | 34 | — | — | 74·5 | 71·2 | 104·6 | 73·6 | 47·5 | 82·7 | 82·9 | 73·9 | 95 | 67° | 73°·5 | 39°·5 |
| | — | — | — | — | — | — | — | 75·8 | 67·7 | 111·8 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 77·9 | 70·9 | 110 | — | — | — | — | — | — | — | — | — |
| | — | 32·5 | 32 | 43 | 36·5 | 77·1 | — | 77·1 | — | — | 72·3 | 47·8 | 83·3 | — | 84·9 | — | — | — | — |
| | — | — | — | — | — | — | — | 70·8 | 65·6 | 108 | — | — | — | — | — | — | — | — | — |
| | — | 35 | 35 | 48 | 36 | 74·2 | 74·7 | 73·4 | 73·9 | 99·3 | — | 50 | 83·3 | — | 75 | 95 | 62°·5 | 76° | 41°·5 |
| | 47 | 35·5 | 35·5 | 51·5 | 40 | 70·6 | 71·1 | 70·2 | 70·7 | 99·2 | — | 47·6 | 75·5 | 75·5 | 77·7 | 102 | 66°·5 | 74°·5 | 39° |
| | — | — | — | — | — | — | — | 75·3 | 74·7 | 100·7 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 73·3 | 71·7 | 102·3 | — | — | — | — | — | — | — | — | — |

Nos. 8 and 48 not seen.

| ACE | | | | | PALATE | | INDICES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | $O_1$ L | $O_1$ R | $O_2$ L | $O_2$ R | $G_1$ | $G_2$ | B/L' | H/L' | B/L | H/L | B/H | G'H/GB | NB/NH | $O_2/O_1$ L | $O_2/O_1$ R | $G_2/G_1$ | GL | N ∠ |
| — | 43 | — | 33 | — | 51 | 35 | 77·7 | 72·3 | 77·7 | 72·3 | 107·4 | — | — | 76·7 | — | 68·6 | 96 | — |
| 5·5 | 44 | 45 | 33·5 | 34 | 52 | 45 | — | — | 71·9 | 70·9 | 101·4 | — | 45·1 | 76·1 | 75·6 | 86·5 | 102 | 62°·5 |
| 3 | 41·5 | 40·5 | 30·5 | 32 | — | 35·5 | 75·4 | — | 75·4 | — | — | 75 | 46·9 | 73·5 | 79 | — | — | — |
| 3 | 42 | 40·5 | 33·5 | 33·5 | 43 | 35 | — | — | 70·2 | — | — | — | 44·2 | 79·8 | 82·7 | 81·4 | — | — |
| — | — | — | — | — | — | — | — | — | 74·9 | 67·9 | 110·2 | — | — | — | — | — | — | — |
| 1 | 42 | 42 | 34·5 | 33·5 | 45·5 | 34·5 | — | — | — | 69·1 | — | 74·7 | 44·2 | 82·1 | 79·8 | 75·8 | 92 | 65° |
| 1 | 44 | 45·5 | 33·5 | 33·5 | 44·5 | 32·5 | 73·3 | 73·3 | 73·3 | 73·3 | 100 | 80·1 | 42 | 76·1 | 73·6 | 73 | 94·5 | 59°·5 |
| — | — | — | — | — | — | — | — | — | 68 | 67 | 101·5 | — | — | — | — | — | — | — |
| 0 | 36 | 35·5 | 34 | 33·5 | 43 | 33·5 | 69 | 66·3 | 69 | 66·3 | 104 | 82·2 | 42·1 | 94·4 | 94·4 | 77·9 | 89 | 65° |
| 2·5 | 40·5 | 41 | 30·5 | 29·5 | 51 | 32 | 77·5 | 74·9 | 77·5 | 74·9 | 103·6 | 76·1 | 46·4 | 75·3 | 71·9 | 62·7 | 94·5 | 62°·5 |
| — | — | — | — | — | — | — | — | — | 71·2 | 69·7 | 102·1 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 75·5 | 68·1 | 111 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 75·1 | 74·6 | 100·8 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 80·9 | 75·6 | 107·1 | — | — | — | — | — | — | — |
| 3 | 42 | 42·5 | 35·5 | 34·5 | 45 | 34 | 67·9 | 65·2 | 67·9 | 65·2 | 104 | 85·1 | 45·1 | 84·5 | 81·2 | 75·6 | 90·5 | 64° |
| 3 | 40 | — | 32·5 | — | 46 | 37·5 | 69·3 | 69·8 | 68·9 | 69·5 | 99·2 | — | 44·2 | 81·2 | — | 81·5 | 95 | 63°·5 |
| 2·5 | 40 | 41 | 33 | 32·5 | 47·5 | 32 | 79·9 | 71·8 | 79·4 | 71·4 | 111·2 | 69·2 | 45·9 | 82·5 | 79·3 | 67·4 | 93 | 67° |
| — | — | — | — | — | — | — | — | — | 74·3 | 69·1 | 107·4 | — | — | — | — | — | — | — |
| — | — | 41 | — | 32 | 45 | — | — | 67·2 | — | 67·2 | — | — | — | — | 78 | — | 92 | 67° |
| — | — | — | — | — | — | — | — | — | — | — | 108·8 | — | — | — | — | — | — | — |
| — | — | 44 | — | 34·5 | — | — | — | — | 75·8 | 71 | 106·7 | — | — | — | 78·4 | — | — | — |
| — | — | — | — | — | — | — | — | — | — | 77·1 | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 79·3 | 73·4 | 108·1 | — | — | — | — | — | — | — |
| — | — | 44·5 | — | 34·5 | — | — | 75·1 | 67·2 | 74·7 | 66·8 | 111·8 | — | — | — | 77·5 | — | 98 | 65° |
| — | — | 45 | — | 30 | — | — | 74·1 | 70·9 | 73·7 | 70·5 | 104·5 | — | — | — | 66·7 | — | — | — |
| — | — | — | — | — | — | — | — | — | 78 | 72·3 | 107·9 | — | — | — | — | — | — | — |
| 5 | 39 | 40 | 33 | 33·5 | 45·5 | 32 | 75·3 | 65 | 75·3 | 65 | 115·7 | 72·2 | 54·3 | 84·6 | 83·7 | 70·3 | 93 | 70° |
| — | — | — | — | — | — | — | — | — | 68·9 | 68·4 | 100·8 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 78·4 | 71 | 110·4 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 72·7 | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 76·1 | 72·3 | 105·3 | — | — | — | — | — | — | — |
| 5·5 | — | 44 | — | 31·5 | 52 | — | 74·2 | 72·6 | 74·2 | 72·6 | 102·2 | — | 52·6 | — | 71·6 | — | 102 | 68°·5 |
| — | — | — | — | — | — | — | — | — | 74·6 | 70·1 | 106·5 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 73·2 | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 70·2 | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | — | 68·5 | — | — | — | — | — | — | — | — |
| — | — | 43 | — | 35 | — | — | 83·5 | 71·6 | 83·5 | 71·6 | 116·7 | — | — | — | 81·4 | — | — | — |
| — | — | — | — | — | — | — | — | — | 75·7 | 72·9 | 103·8 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 76·9 | 71 | 108·3 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 75·1 | 69·2 | 108·6 | — | — | — | — | — | — | — |
| 1·5 | 40·5 | 39 | 34 | 34·5 | 40 | 33·5 | 78·9 | 67·8 | 78·9 | 67·8 | 116·4 | 75·9 | 45·7 | 83·9 | 88·5 | 83·7 | 84 | 63° |
| — | — | — | — | — | — | — | — | — | 76·8 | 68 | 113 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 74 | 66·7 | 111 | — | — | — | — | — | — | — |
| 4 | 44·5 | 45·5 | 33·5 | 33·5 | — | 40? | 74·6 | 72 | 74·2 | 71·6 | 103·7 | 76·4 | 45·3 | 75·3 | 73·6 | — | 96 | 66°·5 |
| 3·5 | 40·5 | 41 | 33·5 | 34 | 46 | 34 | — | — | 74·5 | 71·2 | 104·6 | 73·6 | 47·5 | 82·7 | 82·9 | 73·9 | 95 | 67° |
| — | — | — | — | — | — | — | — | — | 75·8 | 67·7 | 111·8 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 77·9 | 70·9 | 110 | — | — | — | — | — | — | — |
| 2 | 39 | — | 32·5 | 32 | 43 | 36·5 | 77·1 | — | 77·1 | — | — | 72·3 | 47·8 | 83·3 | — | 84·9 | — | — |
| — | — | — | — | — | — | — | — | — | 70·8 | 65·6 | 108 | — | — | — | — | — | — | — |
| 3·5 | 42 | — | 35 | 35 | 48 | 36 | 74·2 | 74·7 | 73·4 | 73·9 | 99·3 | — | 50 | 83·3 | — | 75 | 95 | 62°·5 |
| 4·5 | 47 | 47 | 35·5 | 35·5 | 51·5 | 40 | 70·6 | 71·1 | 70·2 | 70·7 | 99·2 | — | 47·6 | 75·5 | 75·5 | 77·7 | 102 | 66°·5 |
| — | — | — | — | — | — | — | — | — | 75·3 | 74·7 | 100·7 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | 73·3 | 71·7 | 102·3 | — | — | — | — | — | — | — |

Nos. 8 and 48 not seen.

# TABLE I.

| | Angles | | | | | | Remarks |
|---|---|---|---|---|---|---|---|
| *GL* | *N* ∠ | *A* ∠ | *B* ∠ | $\theta_2$ | $\theta_1$ | *P* ∠ | |
| 96 | — | — | — | — | — | — | cal. ad. r. side of face defective |
| 102 | 62°·5 | 77°·5 | 40° | — | — | — | cal. ad. cranial wall large defects |
| — | — | — | — | — | — | 91° | cal. ad. small defects vault and base |
| — | — | — | — | — | — | — | cal. ad. base very imperfect |
| — | — | — | — | — | — | — | cal. – f. old? defects in wall |
| 92 | 65° | 73°·5 | 41°·5 | — | — | — | cal. y. ad. left side very defective, *os pentagonale* |
| 94·5 | 59°·5 | 80°·5 | 40° | 8°·5 | 31°·5 | 89° | cal. ad. |
| — | — | — | — | — | — | — | cal. – f. ad. defect in vault |
| 89 | 65° | 75°·5 | 39°·5 | 14°·5 | 25° | 90° | cal. y. ad. zygom. arches defective. infantile type of forehead. somewhat plagiocephalic. post coronal constriction; r. occipital flattening |
| 94·5 | 62°·5 | 78° | 39°·5 | 11° | 28°·5 | 89° | cal. ad. |
| — | — | — | — | — | — | — | cal. – f. ad. defective ethmoidal region |
| — | — | — | — | — | — | — | cal. – f. ad. defective base, numerous worm. ossicles in lambdoid suture; ossicle 18 × 8 mm. in r. coronal |
| — | — | — | — | — | — | — | cal. – f. old? [suture |
| — | — | — | — | — | — | — | cal. – f. sen? fracture across base. slight projection on basi-occipital [poral region |
| 90·5 | 64° | 71° | 45° | 15° | 30° | 86° | cal. ad. post mortem depression and defect in l. tem- |
| 95 | 63°·5 | 74° | 42°·5 | 15° | 27°·5 | 89° | cal. ad. right side of face, l. zygom. arch defective. wormian bone on hinder part sagit. suture |
| 93 | 67° | 74° | 39° | 11° | 28° | 85° | cal. ad. |
| — | — | — | — | — | — | — | cal. – f. y. ad. two wormian bones, together 37 × 26 mm., in hinder part of sagit. sut. projecting into r. parietal bone |
| 92 | 67° | 72° | 41° | 15° | 26° | 87° | cal. y. ad. very imperfect |
| — | — | — | — | — | — | — | cal. – f. y. ad. large occipital defect. metopic; slight post coronal constriction; bilateral frontal process of squamous temporal; slight depression of obelion |
| — | — | — | — | — | — | — | cal. – f. + r. orbit. ad. |
| — | — | — | — | — | — | — | cal. – f. ad. with defects r. side. [depression obelion |
| — | — | — | — | — | — | — | cal. – f. ad. slight defect anteriorly. metopic; slight |
| 98 | 65° | 72° | 43° | 13° | 30° | 85° | cal. ad. l. side of face defective. slightly bathrocephalic |
| — | — | — | — | — | — | — | cal. ad. large defect l. side |
| — | — | — | — | — | — | — | cal. – f. ad. slight bathrocephaly |
| 93 | 70° | 70° | 40° | 13° | 27° | 83° | cal. old. faint depression obelion |
| — | — | — | — | — | — | — | cal. – f. ad. considerable defect in forepart of base |
| — | — | — | — | — | — | — | cal. – f. y. ad. slight *torus occipitalis* |
| — | — | — | — | — | — | — | dome. ad. wormian bones between occipital, parietal |
| — | — | — | — | — | — | — | cal. – f. old. defective in r. parietal [and mastoid |
| 102 | 68°·5 | 73°·5 | 38° | 10°·5 | 27°·5 | 84° | cal. y. ad. l. side of face defective |
| — | — | — | — | — | — | — | cal. – f. old. defects in base and l. temporal |
| — | — | — | — | — | — | — | dome. ad. with fracture |
| — | — | — | — | — | — | — | cal. – f. ad. large occipital defect [to r. temporal |
| — | — | — | — | — | — | — | cal. – f. ad. with l. parietal defect. frontal process |
| — | — | — | — | — | — | — | cal. – f. + r. orbit. ad. |
| — | — | — | — | — | — | — | cal. – f. ad. defective r. temporal and ethmoidal regions |
| — | — | — | — | — | — | — | cal. – f. old. defective base [bathrocephaly |
| — | — | — | — | — | — | — | cal. – f. ad. metopic; post coronal depression; slight |
| 84 | 63° | 75° | 42° | 14° | 28° | 89° | cal. ad. r. parietal and l. occipital defects; slight post coronal depression [part sagital suture |
| — | — | — | — | — | — | — | cal. – f. y. ad. metopic; wormian bones in hinder |
| — | — | — | — | — | — | — | cal. – f. ad. depression of obelion |
| 96 | 66°·5 | 73° | 40°·5 | 8° | 32°·5 | 81° | cal. ad. [dylar eminences on basi-occipital bilateral |
| 95 | 67° | 73°·5 | 39°·5 | — | — | — | cal. y. ad. l. temporal bone wanting; small precon- |
| — | — | — | — | — | — | — | cal. – f. ad. defects in base, slight post coronal de- |
| — | — | — | — | — | — | — | cal. – f. y. ad. [pression |
| — | — | — | — | — | — | 88° | cal. ad. defects in base and r. malar region |
| — | — | — | — | — | — | — | cal. – f. ad. |
| 95 | 62°·5 | 76° | 41°·5 | 10° | 31°·5 | 86° | cal. ad. defect in r. malar region |
| 102 | 66°·5 | 74°·5 | 39° | 10°·5 | 28°·5 | 85° | cal. y. ad. l. zygomatic defect |
| — | — | — | — | — | — | — | cal. – f. ad. sphenoid and temporal defective l. side. marked bathrocephaly; numerous wormian bones in lambdoid suture, slight *torus occipitalis* |
| — | — | — | — | — | — | — | cal. – f. ad. considerable defects |

| | | | Lengths | | | | | | | | Circumferences | | | Face | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Series No. | Sex | C | F | L' | L | B | B' | H | OH | LB | U | S | Q | G'H | GB | J | NH | NB | $O_1$ L | $O_1$ R | $O_2$ L |
| 56 | ♀ | — | — | — | — | 139 | 95 | 127? | 114 *h* | 92 | — | — | 314 | — | — | — | — | — | — | — | — |
| 57 | ♀ | 1375 | 180 | — | 180 | 138 | 95 | 130 | 114 *h* | 98 | 508 | 364 | 305 | — | — | — | — | — | — | — | — |
| 58 | ♂ ?? | 1365 | 186 | 180 | 186 | 134 | 92 | 129 | 117 | 94 | 511 | 380 | 302 | 65 | 82 | 119 | 46 | 23·5 | 40·5 | 40·5 | 30·5 |
| 59 | ♀ | — | 175 | — | 177 | 128 | 86 | — | 106 *h* | — | 491 | 352 | 280 | — | — | — | — | — | — | — | — |
| 60 | ♂ | 1390 | 187 | 188 | 188 | 140 | 101 | 127 | 112 | 97 | 524 | 373 | 306 | — | 87 | — | 48 | 22·5 | — | 42 | 32·5 |
| 61 | ♂? | 1410 | 177 | 180 | 180 | 135 | 92 | 130 | 115 | 98 | 505 | 362 | 309 | 71 | — | — | 52 | 22·5 | 41 | 41 | 33·5 |
| 62 | ♂ | 1585 | 191 | 190 | 191 | 141 | 96 | 137 | 119 | 103 | 530 | 385 | 319 | 77·5 | 88 | — | 56 | 25 | — | 46 | — |
| 63 | ♀ | — | 181 | 180 | 181 | 137 | 100 | 124 | 109 | 97 | 511 | 362 | 297 | 65 | 86 | — | 46 | 23 | 42·5 | 41·5 | 33·5 |
| 65 | ♂ | — | 197 | — | 199 | 143 | 100 | — | 121 *h* | — | 546 | 402 | 324 | — | — | — | — | — | — | — | — |
| 66 | ♀ | 1290 | 176 | 174 | 175 | 132 | 101 | 121 | 107 | 93 | 500 | 350 | 292 | — | — | 118 | — | — | — | 41·5 | — |
| 67 | ♀ | 1425 | 181 | — | 182 | 138 | 94 | 124 | 111 *h* | 94 | 509 | 358 | 301 | — | — | — | — | — | — | — | — |
| 68 | ♀ | 1170 | 167 | — | 167 | 136 | 89 | 126 | 108 *h* | 92 | 481 | 350 | 292 | — | — | — | — | — | — | — | — |
| 69 | ♂ | 1470 | 185 | 188 | 188 | 134 | 99 | 135 | 117 | 101 | 513 | 381 | 303 | 66 | 91 | 128 | 50 | 25·5 | 41·5 | 42·5 | 31·5 |
| 70 | ♀ | — | 188 | — | 188 | 143 | 96 | — | 113? *h* | — | 533 | — | 307 | — | — | — | — | — | — | — | — |
| 71 | ♀ | 1160 | 178 | — | 179 | 135 | 90 | 114 | 99 *h* | 91 | 500 | 349 | 275 | — | — | — | — | — | — | — | — |
| 72 | ♂ | — | 191 | 194 | 194 | 146 | 101 | — | 115 | — | 541 | 389 | 310 | 77 | — | — | 57 | 26 | 41 | 40 | 32·5 |
| 73 | ♀ | — | 170 | — | 170 | 129 | 94 | 118 | 102 *h* | 89 | 482 | 342 | 283 | — | — | — | — | — | — | — | — |
| 74 | ♂? | 1340 | 176 | — | 179 | 139 | 98 | 136 | 108 *h* | 105 | 509 | 351 | 305 | — | — | — | — | — | — | — | — |
| 75 | ♂?? | — | 176 | 177 | 178 | — | 96 | 120 | 109 | 96 | 492 | — | 296 | 72·5 | 96 | — | 52·5 | 28 | 41·5 | 41 | 33 |
| 76 | ♂ | — | 189 | 191 | 191 | 134 | 94 | 132 | 110 | 102 | 519 | — | 294 | 71 | — | — | 49 | 22·5 | — | 42 | — |
| 77 | ♂ | — | 190 | 192 | 193 | 142 | — | 131 | 116 | 96 | — | 392 | 306 | 71 | 88 | — | 51 | 23·5 | 42 | — | 34 |
| 78 | ♀ | 1220 | 179 | 180 | 180 | 130 | 92 | 125 | 108 | 97 | 497 | 357 | 287 | — | — | — | 50 | 25 | — | 41 | — |
| 79 | ♂ | 1400 | 196 | — | 200 | 133 | 88 | 133 | 108 *h* | 104 | 530 | 394 | 289 | — | — | — | — | — | — | — | — |
| 80 | ♀ | — | 164 | — | 165 | 124 | 91 | 110 | 101 *h* | 81 | 461 | 334 | — | 61 | 78 | — | 44 | 21 | 39 | 40 | 30·5 |
| 81 | ♂? | 1415 | 183 | 183 | 183 | 139 | 97 | 133 | 120 | 98 | 513 | 376 | 308 | 70 | 88 | — | 50·5 | 25 | 42 | 42 | 33 |
| 82 | ♂ | 1475 | 177 | — | 178 | 149 | 99 | 134 | 113 *h* | 97 | 517 | 370 | 312 | — | — | — | — | — | — | — | — |
| 83 | ♀? | 1360 | 178 | — | 178 | 137 | 95 | 123 | 111 *h* | 92 | 505 | 357 | 296 | — | — | — | — | — | — | — | — |
| 84 | ♂?? | 1360 | 175 | 177 | 177 | 137 | 91 | 126 | 110 | 95 | 500 | 362 | 295 | 70 | 92 | 124 | 52 | 23·5 | 41 | 40·5 | 32·5 |
| 85 | ♂? | 1305 | 179 | 180 | 181 | 131 | 89 | 126 | 109 | 98 | 496 | 367 | 292 | 68 | 76 | 117 | 50 | 20 | 41 | 42 | 34·5 |
| 86 | ♀? | 1305 | 172 | 172 | 173 | 136 | 96 | 131 | 113 | 96 | 495 | 355 | 302 | — | 88 | 124 | 51·5 | 21 | 41 | 39 | 36 |
| 87 | ♀ | — | 184 | — | 184 | 134 | 89 | 118 | 110 *h* | 88 | 512 | 382 | 291 | — | — | — | — | — | — | — | — |
| 88 | ♂ | — | 194 | — | 199 | 140 | 95 | 116 | 110 *h* | 102 | 530 | 377 | — | 69 | — | — | 52·5 | 24 | — | — | — |
| 89 | ♂ | 1660 | 187 | — | 188 | 143 | 100 | 142 | 120 *h* | 101 | 522 | 385 | 322 | — | — | — | — | — | — | — | — |
| 90 | ♀ | — | 177 | 175 | 176 | 135 | 91 | 119 | 105 | 88 | 498 | 357 | 287 | — | 84 | — | 46·5 | 24 | — | 37·5 | 32·5 |
| 91 | ♂ | 1415 | 182 | 183 | 184 | 143 | 97 | 131 | 113 | 97 | 516 | 371 | 308 | 70 | 90 | 127 | 52·5 | 24 | 40·5 | 41·5 | 34 |
| 92 | ♀ | 1160 | 172 | — | 173 | 131 | 85 | 120 | 102 *h* | 93 | 485 | — | 276 | — | — | — | — | — | — | — | — |
| 93 | ♀ | — | 174 | — | 177 | 139 | 87 | 124 | 108 *h* | 96 | 493 | — | — | — | — | — | — | — | — | — | — |
| 94 | ♂ | — | 197 | — | 197 | 149 | 97 | — | 120 *h* | — | 555 | 406 | 332 | — | — | — | — | — | — | — | — |
| 95 | ♀ | 1395 | 183 | — | 181 | 135 | 99 | 129 | 113 *h* | 101 | 506 | 362 | 303 | — | — | — | — | — | — | — | — |
| 96 | ♂ | 1400 | 189 | — | 189 | 136 | 102 | 132 | 113 *h* | 107 | 525 | 365 | 302 | — | — | — | — | — | — | — | — |
| 97 | ♀ | — | 187 | — | 188 | 136 | 95 | — | 113 *h* | — | 512 | 382 | — | 66 | 80 | — | 49·5 | 24·5 | 40·5 | 40·5 | 35 |
| 98 | ♂ | — | 179 | 180 | 181 | 141 | 99 | 139 | 118 | 97 | 511 | 378 | 311 | 74 | 96 | 131 | 50 | 26 | 41·5 | 40·5 | 32·5 |

| | $O_1$ | | $O_2$ | | Palate | | Indices | | | | | | | | | | | A | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R | L | R | $G_1$ | $G_2$ | $B/L'$ | $H/L'$ | $B/L$ | $H/L$ | $B/H$ | $C'H/GB$ | $NB/NH$ | $O_2/O_1$ L | $O_2/O_1$ R | $G_2/G_1$ | $GL$ | $N\angle$ | $A\angle$ | $B\angle$ |
| | — | — | — | — | — | — | — | — | — | 109·4 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 76·7 | 72·2 | 106·1 | — | — | — | — | — | — | — | — | — |
| | 40·5 | 30·5 | 30·5 | 48·5 | 37 | 72 | 69·3 | 72 | 69·3 | 103·8 | 79·3 | 51·1 | 75·3 | 75·3 | 76·3 | 95 | 71° | 69° | 40° |
| | — | — | — | — | — | — | — | 72·3 | — | — | — | — | — | — | — | — | — | — | — |
| | 42 | 32·5 | 32·5 | 44 | — | 74·5 | 67·5 | 74·5 | 67·5 | 110·2 | — | 46·9 | — | 77·4 | — | 89·5 | — | — | — |
| | 41 | 33·5 | 33 | — | — | 75 | 72·2 | 75 | 72·2 | 103·8 | — | 43·3 | 81·7 | 80·5 | — | 86 | 58°·5 | 77° | 44°·5 |
| | 46 | — | 37·5 | 50 | 34 | 74·2 | 72·1 | 73·8 | 71·7 | 102·9 | 88·1 | 44·6 | — | 81·5 | 68 | 99 | 65° | 70° | 45° |
| 5 | 41·5 | 33·5 | 33·5 | 46 | — | 76·1 | 68·9 | 75·7 | 68·5 | 110·5 | 75·6 | 50 | 78·8 | 80·7 | — | 92 | 66° | 74° | 40° |
| | — | — | — | — | — | — | — | 71·9 | — | — | — | — | — | — | — | — | — | — | — |
| | 41·5 | — | 36 | — | — | 75·9 | 69·5 | 75·4 | 69·1 | 109 | — | — | — | 86·7 | — | — | — | — | — |
| | — | — | — | — | — | — | — | 75·8 | 68·1 | 111·2 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 81·4 | 75·4 | 108 | — | — | — | — | — | — | — | — | — |
| 5 | 42·5 | 31·5 | 31·5 | 49 | 40 | 71·3 | 71·8 | 71·3 | 71·8 | 99·3 | 72·5 | 51 | 75·9 | 74·1 | 81·6 | 99 | 69° | 72°·5 | 38°·5 |
| | — | — | — | — | — | — | — | 76·1 | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 75·4 | 63·7 | 118·5 | — | — | — | — | — | — | — | — | — |
| | 40 | 32·5 | 33 | 49 | 37 | 75·3 | — | 75·3 | — | — | — | 45·6 | 79·3 | 82·5 | 75·5 | — | — | — | — |
| | — | — | — | — | — | — | — | 75·9 | 69·4 | 109·3 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 77·6 | 76 | 102·2 | — | — | — | — | — | — | — | — | — |
| 5 | 41 | 33 | 32 | 51·5 | 36 | — | 67·8 | — | 67·4 | — | 75·5 | 53·3 | 79·5 | 78 | 69·9 | 96 | 68° | 68° | 44° |
| | 42 | — | 34 | 49 | 35 | 70·2 | 69·1 | 70·2 | 69·1 | 101·5 | — | 45·9 | — | 80·9 | 71·4 | 100·5 | 68° | 71° | 41° |
| | — | 34 | — | 48 | 38 | 74 | 68·2 | 73·6 | 67·9 | 108·4 | 80·7 | 46·1 | 80·9 | — | 79·2 | 92·5 | 65°·5 | 71° | 43°·5 |
| | 41 | — | 33·5 | — | — | 72·2 | 69·4 | 72·2 | 69·4 | 104 | — | 50 | — | 81·7 | — | — | — | — | — |
| | — | — | — | — | — | — | — | 66·5 | 66·5 | 100 | — | — | — | — | — | — | — | — | — |
| | 40 | 30·5 | 30·5 | 41·5 | — | — | — | 75·1 | 66·7 | 112·7 | 78·2 | 47·7 | 78·2 | 76·2 | — | 78 | 65° | 70° | 45° |
| | 42 | 33 | 33 | 46·5 | 35 | 76 | 72·7 | 76 | 72·7 | 104·5 | 79·5 | 49·5 | 78·6 | 78·6 | 75·3 | 91·5 | 63°·5 | 73° | 43°·5 |
| | — | — | — | — | — | — | — | 83·7 | 75·3 | 111·2 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 77 | 69·1 | 111·3 | — | — | — | — | — | — | — | — | — |
| | 40·5 | 32·5 | 31·5 | — | 35·5 | 77·4 | 71·2 | 77·4 | 71·2 | 108·7 | 76·1 | 45·2 | 79·3 | 77·8 | — | 89 | 63° | 73° | 44° |
| | 42 | 34·5 | 35·5 | 43 | — | 72·8 | 70 | 72·4 | 69·6 | 103·9 | 69·5 | 40 | 84·1 | 84·5 | — | 85·5 | 59° | 78° | 43° |
| | 39 | 36 | 36 | 45 | 33·5 | 79·1 | 76·2 | 78·6 | 75·7 | 103·8 | — | 40·8 | 87·8 | 92·3 | 74·4 | — | — | — | — |
| | — | — | — | — | — | — | — | 72·8 | 64·1 | 113·5 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 70·3 | 58·3 | 120·6 | — | 45·7 | — | — | — | 97·5 | 66°·5 | 73°·5 | 40° |
| | — | — | — | — | — | — | — | 76·1 | 75·5 | 100·7 | — | — | — | — | — | — | — | — | — |
| | 37·5 | 32·5 | 32·5 | 41 | 37·5 | 77·1 | 68 | 76·7 | 67·6 | 113·5 | — | 51·6 | — | 86·7 | 91·5 | — | — | — | — |
| 5 | 41·5 | 34 | 34·5 | 45 | — | 78·1 | 71·6 | 77·7 | 71·2 | 109·2 | 77·8 | 45·7 | 83·9 | 83·1 | — | 93·5 | 66° | 71° | 43° |
| | — | — | — | — | — | — | — | 75·7 | 69·4 | 109·2 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 78·5 | 70·1 | 112·1 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 75·6 | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 74·6 | 71·3 | 104·6 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 72 | 69·8 | 103 | — | — | — | — | — | — | — | — | — |
| 5 | 40·5 | 35 | 34·5 | 45 | 32 | — | — | 72·3 | — | — | 2·5 | 49·5 | 86·4 | 85·2 | 71·1 | — | — | — | — |
| 5 | 40·5 | 32·5 | 33·5 | 51·5 | 37·5 | 78·3 | 77·2 | 77·9 | 76·8 | 101·4 | 7·1 | 52 | 78·3 | 82·7 | 72·8 | 98·5 | 69° | 67° | 44° |

64 Not seen.

| | | | | | Palate | | Indices | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $O_1$ | | $O_2$ | | | | | | | | | | | | | | | | | |
| $L$ | $R$ | $L$ | $R$ | $G_1$ | $G_2$ | $B/L'$ | $H/L'$ | $B/L$ | $H/L$ | $B/H$ | $CH/GB$ | $NB/NH$ | $O_2/O_1$ $L$ | $O_2/O_1$ $R$ | $G_2/G_1$ | $GL$ | $N\angle$ | |
| — | — | — | — | — | — | — | — | — | — | 109·4 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | 76·7 | 72·2 | 106·1 | — | — | — | — | — | — | — | |
| 40·5 | 40·5 | 30·5 | 30·5 | 48·5 | 37 | 72 | 69·3 | 72 | 69·3 | 103·8 | 79·3 | 51·1 | 75·3 | 75·3 | 76·3 | 95 | 71° | |
| — | — | — | — | — | — | — | — | 72·3 | — | — | — | — | — | — | — | — | — | |
| — | 42 | 32·5 | 32·5 | 44 | — | 74·5 | 67·5 | 74·5 | 67·5 | 110·2 | — | 46·9 | — | 77·4 | — | 89·5 | — | |
| 41 | 41 | 33·5 | 33 | — | — | 75 | 72·2 | 75 | 72·2 | 103·8 | — | 43·3 | 81·7 | 80·5 | — | 86 | 58°·5 | |
| — | 46 | — | 37·5 | 50 | 34 | 74·2 | 72·1 | 73·8 | 71·7 | 102·9 | 88·1 | 44·6 | — | 81·5 | 68 | 99 | 65° | |
| 42·5 | 41·5 | 33·5 | 33·5 | 46 | — | 76·1 | 68·9 | 75·7 | 68·5 | 110·5 | 75·6 | 50 | 78·8 | 80·7 | — | 92 | 66° | |
| — | — | — | — | — | — | — | — | 71·9 | — | — | — | — | — | — | — | — | — | |
| — | 41·5 | — | 36 | — | — | 75·9 | 69·5 | 75·4 | 69·1 | 109 | — | — | — | 86·7 | — | — | — | |
| — | — | — | — | — | — | — | — | 75·8 | 68·1 | 111·2 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | 81·4 | 75·4 | 108 | — | — | — | — | — | — | — | |
| 41·5 | 42·5 | 31·5 | 31·5 | 49 | 40 | 71·3 | 71·8 | 71·3 | 71·8 | 99·3 | 72·5 | 51 | 75·9 | 74·1 | 81·6 | 99 | 69° | |
| — | — | — | — | — | — | — | — | 76·1 | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | 75·4 | 63·7 | 118·5 | — | — | — | — | — | — | — | |
| 41 | 40 | 32·5 | 33 | 49 | 37 | 75·3 | — | 75·3 | — | — | — | 45·6 | 79·3 | 82·5 | 75·5 | — | — | |
| — | — | — | — | — | — | — | — | 75·9 | 69·4 | 109·3 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | 77·6 | 76 | 102·2 | — | — | — | — | — | — | — | |
| 41·5 | 41 | 33 | 32 | 51·5 | 36 | — | 67·8 | — | 67·4 | — | 75·5 | 53·3 | 79·5 | 78 | 69·9 | 96 | 68° | |
| — | 42 | — | 34 | 49 | 35 | 70·2 | 69·1 | 70·2 | 69·1 | 101·5 | — | 45·9 | — | 80·9 | 71·4 | 100·5 | 68° | |
| 42 | — | 34 | — | 48 | 38 | 74 | 68·2 | 73·6 | 67·9 | 108·4 | 80·7 | 46·1 | 80·9 | — | 79·2 | 92·5 | 65°·5 | |
| — | 41 | — | 33·5 | — | — | 72·2 | 69·4 | 72·2 | 69·4 | 104 | — | 50 | — | 81·7 | — | — | — | |
| — | — | — | — | — | — | — | — | 66·5 | 66·5 | 100 | — | — | — | — | — | — | — | |
| 39 | 40 | 30·5 | 30·5 | 41·5 | — | — | — | 75·1 | 66·7 | 112·7 | 78·2 | 47·7 | 78·2 | 76·2 | — | 78 | 65° | |
| 42 | 42 | 33 | 33 | 46·5 | 35 | 76 | 72·7 | 76 | 72·7 | 104·5 | 79·5 | 49·5 | 78·6 | 78·6 | 75·3 | 91·5 | 63°·5 | |
| — | — | — | — | — | — | — | — | 83·7 | 75·3 | 111·2 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | 77 | 69·1 | 111·3 | — | — | — | — | — | — | — | |
| 41 | 40·5 | 32·5 | 31·5 | — | 35·5 | 77·4 | 71·2 | 77·4 | 71·2 | 108·7 | 76·1 | 45·2 | 79·3 | 77·8 | — | 89 | 63° | |
| 41 | 42 | 34·5 | 35·5 | 43 | — | 72·8 | 70 | 72·4 | 69·6 | 103·9 | 69·5 | 40 | 84·1 | 84·5 | — | 85·5 | 59° | |
| 41 | 39 | 36 | 36 | 45 | 33·5 | 79·1 | 76·2 | 78·6 | 75·7 | 103·8 | — | 40·8 | 87·8 | 92·3 | 74·4 | — | — | |
| — | — | — | — | — | — | — | — | 72·8 | 64·1 | 113·5 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | 70·3 | 58·3 | 120·6 | — | 45·7 | — | — | — | 97·5 | 66°·5 | |
| — | — | — | — | — | — | — | — | 76·1 | 75·5 | 100·7 | — | — | — | — | — | — | — | |
| — | 37·5 | 32·5 | 32·5 | 41 | 37·5 | 77·1 | 68 | 76·7 | 67·6 | 113·5 | — | 51·6 | — | 86·7 | 91·5 | — | — | |
| 40·5 | 41·5 | 34 | 34·5 | 45 | — | 78·1 | 71·6 | 77·7 | 71·2 | 109·2 | 77·8 | 45·7 | 83·9 | 83·1 | — | 93·5 | 66° | |
| — | — | — | — | — | — | — | — | 75·7 | 69·4 | 109·2 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | 78·5 | 70·1 | 112·1 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | 75·6 | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | 74·6 | 71·3 | 104·6 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | 72 | 69·8 | 103 | — | — | — | — | — | — | — | |
| 40·5 | 40·5 | 35 | 34·5 | 45 | 32 | — | — | 72·3 | — | — | 2·5 | 49·5 | 86·4 | 85·2 | 71·1 | — | — | |
| 41·5 | 40·5 | 32·5 | 33·5 | 51·5 | 37·5 | 78·3 | 77·2 | 77·9 | 76·8 | 101·4 | 7·1 | 52 | 78·3 | 82·7 | 72·8 | 98·5 | 69° | |

64 Not seen.

# TABLE II.

| | Angles | | | | | | Remarks |
|---|---|---|---|---|---|---|---|
| *GL* | *N* ∠ | *A* ∠ | *B* ∠ | $\theta_2$ | $\theta_1$ | *P* ∠ | |
| — | — | — | — | — | — | — | cal. – f. ad. hinder part defective. infantile forehead |
| — | — | — | — | — | — | — | cal. – f. ad. small r. parietal defect. ossicle of asterion, bilateral. left mandibular articulation imperfectly developed |
| 95 | 71° | 69° | 40° | 15° | 25° | 84° | cal. y. ad. both zygomatic arches defective. depression r. frontal. slight precondylar eminences on basi-occipital, bilateral |
| — | — | — | — | — | — | — | dome. ad. |
| 89·5 | — | — | — | — | — | — | cal. ad. l. malar defect. |
| 86 | 58°·5 | 77° | 44°·5 | 16° | 28°·5 | 93° | cal. ad. left zygomat. arch and r. maxilla defective |
| 99 | 65° | 70° | 45° | 15° | 30° | 85° | cal. old. l. malar defect. [arch metopic |
| 92 | 66° | 74° | 40° | 11° | 29° | 85° | cal. y. ad. defect in r. parietal and l. zygom. |
| — | — | — | — | — | — | — | cal. – f. ad. defect centre of base. small occipital torus. traces of ossicles in lambdoid suture. depression in obelion |
| — | — | — | — | — | — | — | cal. – f. + r. malar bone. ad. ossicle to left of λ. |
| — | — | — | — | — | — | — | cal. – f. y. ad. small defect r. occipital. slight de- |
| — | — | — | — | — | — | — | cal. – f. ad. fractured base [pression of obelion |
| 99 | 69° | 72°·5 | 38°·5 | 9°·5 | 29° | 82° | cal. old. slight bathrocephaly |
| — | — | — | — | — | — | — | cal. – f. old. defect centre of base |
| — | — | — | — | — | — | — | cal. – f. old. ethmoidal defect. Projection 3 × 3 mm. at basion into foramen (? rudimentary *condylus tertius*) |
| — | — | — | — | — | — | 85° | cal. senile. both zygom. arches and centre of base defective. metopic suture nearly closed. bilateral frontal process of squamous temporal. small *torus occipitalis*. traces of ossicles in lambdoid suture |
| — | — | — | — | — | — | — | cal. – f. y. ad. defects in base, ethmoidal and l. temporal. metopic. extensive flattening of obelion. small bilateral precondylar eminences on basi-occipital |
| — | — | — | — | — | — | — | cal. – f. y. ad. ossicles in hinder part sagit. suture |
| 96 | 68° | 68° | 44° | 21° | 23° | 89° | cal. ad. defective l. zygom., l. parietal and occipito-temporal. negroid appearance ? |
| 100·5 | 68° | 71° | 41° | 10° | 31° | 81° | cal. ad. defect frontal and l. side face. irregular line of lambdoid suture |
| 92·5 | 65°·5 | 71° | 43°·5 | 17° | 26°·5 | 88° | cal. ad. defect r. frontal and malar |
| — | — | — | — | — | — | — | cal. old. defect l. side face |
| — | — | — | — | — | — | — | cal. – f. old. sagit. sut. completely obliterated |
| 78 | 65° | 70° | 45° | — | — | — | cal. y. ad. right temporal defect. wormians in lamb- |
| 91·5 | 63°·5 | 73° | 43°·5 | 18° | 25°·5 | 91° | cal. y. ad. l. zygoma defective [doid suture |
| — | — | — | — | — | — | — | cal. – f. y. ad. r. ossicle of pterion |
| — | — | — | — | — | — | — | cal. – f. y. ad. slight ethmoidal defect, r. ossicle of |
| 89 | 63° | 73° | 44° | 14° | 30° | 87° | cal. ad. [pterion |
| 85·5 | 59° | 78° | 43° | 14° | 29° | 92° | cal. ad. projection 8 mm. long from hinder margin of external pterygoid plate on r. side |
| — | — | — | — | — | — | — | cal. y. ad. projection 4 mm. long from hinder margin of external pterygoid plate on r. side. metopic suture persisting for 23 mm. at upper end |
| — | — | — | — | — | — | — | cal. – f. ad. frontal defect |
| 97·5 | 66°·5 | 73°·5 | 40° | — | — | — | cal. ad. r. occipito-temporal defect, face defective on both sides. heavy brow ridges. slight bathrocephaly |
| — | — | — | — | — | — | — | cal. – f. ad. slight ethmoidal defect [fective |
| — | — | — | — | — | — | — | cal. old. large occipital defect, both zygomata de- |
| 93·5 | 66° | 71° | 43° | 16° | 27° | 87° | cal. ad. both zygomata defective |
| — | — | — | — | — | — | — | cal. – f. ad. small occipital defect |
| — | — | — | — | — | — | — | cal. – f. ad. base very defective |
| — | — | — | — | — | — | — | cal. – f. ad. centre of base defective |
| — | — | — | — | — | — | — | cal. – f. ad. metopic suture persisting for 35 mm. at upper end, traces of trans-occipital suture for about 20 mm. ossicle in fore part l. squamous suture |
| — | — | — | — | — | — | — | cal. – f. ad. slight ethmoidal defect. post parietal flattening and slight depression of obelion. traces of trans-occipital suture for 45 mm. on l. side |
| — | — | — | — | — | — | — | cal. old. large occipital and l. temporal defect, three ossicles in lambdoid suture, largest 20 × 10 mm. |
| 98·5 | 69° | 67° | 44° | 15° | 29° | 82° | cal. ad. right temporal defect |

| | | | Lengths | | | | | | | | Circumferences | | | Face | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Series No. | Sex | *C* | *F* | *L'* | *L* | *B* | *B'* | *H* | *OH* | *LB* | *U* | *S* | *Q* | *G'H* | *GB* | *J* | *NH* | *NB* | $O_1$ *L* | $O_1$ *R* | $O_2$ *L* |
| 99 | ♀ | — | 182 | 182 | 182 | 130 | 95 | 127 | 107 | 101 | 498 | 356 | 290 | — | 90 | 129 | 46 | 25·5 | 43 | 43·5 | 32·5 |
| 100 | ♂ | — | 185 | — | 186 | 143 | 98 | — | 120 *h* | — | 527 | — | 312 | — | — | — | — | — | — | — | — |
| 101 | ♀ | — | 179 | — | 180 | 129 | 89 | 132 | 115 *h* | 100 | 498 | 362 | 296 | — | — | — | — | — | — | — | — |
| 102 | ♀ | 1260 | 185 | — | 185 | 132 | 94 | 126 | — | 101 | 507 | 364 | 292 | 71 | 79 | — | 49·5 | 20 | — | — | — |
| 103 | ♂ | — | 189 | — | 192 | 143 | 95 | 130 | 117 *h* | 98 | 527 | 386 | 303 | — | — | — | — | — | — | — | — |
| 104 | ♀ | 1325 | 179 | — | 180 | 133 | 87 | 121 | 105 *h* | 92 | 499 | 353 | 282 | — | — | — | — | — | — | — | — |
| 105 | ♀ | 1245 | 171 | 172 | 171 | 134 | 96 | 119 | 105 | 89 | 489 | 350 | 280 | 70 | 83 | 119 | 49·5 | 23·5 | 42 | 42 | 35·5 |
| 106 | ♀ | — | 183 | — | 183 | 133 | 103 | — | 103 *h* | — | 510 | — | — | — | — | — | — | — | — | — | — |
| 107 | ♀ | — | 190 | 190 | 190 | 139 | 94 | 121 | 113 | 100 | 525 | 375 | 310 | 62 | 80 | — | 45·5 | 24 | — | 38·5 | 32·5 |
| 108 | ♀ | — | 188 | — | 188 | — | 97 | — | — | — | 525 | 380 | — | — | — | — | — | — | — | — | — |
| 109 | ♀ | — | 193 | — | 193 | — | 97 | 127 | 112 *h* | 98 | 522 | 382 | 302 | — | — | — | — | — | — | — | — |
| 110 | ♂ | — | 196 | — | 199 | 141 | 100 | — | 115? *h* | — | 541 | 380 | — | — | — | — | — | — | — | — | — |
| 111 | ♂ | — | 188 | — | 191 | — | 99 | 134 | 113 *h* | 109 | 520 | 366 | 306 | — | — | — | — | — | — | — | — |
| 112 | ♀ | — | 185 | — | — | 129 | 89 | — | — | — | 507 | — | 295 | — | — | — | — | — | — | — | — |
| 113 | ♀ | — | 186 | — | 185 | 141 | 97 | 127 | 106 *h* | 95 | 518 | 369 | — | — | — | — | — | — | — | — | — |
| 114 | ♀ | 1245 | 181 | 180 | 181 | 131 | 98 | 121 | 106 | 101 | 505 | 350 | 288 | 70·5 | 85 | 119 | 53 | 24·5 | 41 | 41 | 35 |
| 115 | ♂ | 1410 | 177 | — | 180 | 140 | 102 | 144 | 120 *h* | 103 | 512 | 375 | 314 | — | — | — | — | — | — | — | — |
| 116 | ♀ | — | — | — | — | 135 | 91 | — | — | — | — | — | — | — | 84 | 118 | — | — | — | — | — |
| 117 | ♂? | — | 184 | — | 186 | 138 | 93 | 127 | 109 *h* | 97 | 515 | — | — | — | — | — | — | — | — | — | — |
| 118 | ♀ | — | 184 | — | 181 | 146 | 93 | — | 112 *h* | — | 519 | 391 | 307 | — | — | — | — | — | — | — | — |
| 119 | ♀ | 1355 | 182 | — | 181 | 138 | 93 | 121 | 106 *h* | 91 | 507 | 368 | 293 | — | — | — | — | — | — | — | — |
| 120 | ♂ | 1460 | 182 | 185 | 184 | 138 | 104 | 137 | 116 | 95 | 513 | 385 | 309 | 65 | 94 | 135 | 50 | 33 | 44 | 44·5 | 31·5 |
| 121 | ♀ | 1225 | 180 | 182 | 181 | 128 | 90 | 121 | 103 | 99 | 495 | 350 | 273 | 68·5 | 85 | 116 | 49·5 | 24·5 | 42·5 | 42 | 35 |
| 122 | ♂ | — | 185 | — | 186 | 136 | — | 130 | 112 *h* | 104 | 514 | 362 | — | 61·5 | — | — | 49·5 | — | 41·5 | — | 31 |
| 123 | ♂ | 1570 | 194 | — | 197 | 138 | 100 | 139 | 118 *h* | 105 | 535 | 393 | 314 | — | — | — | — | — | — | — | — |
| 124 | ♂? | — | 194 | 194 | 195 | 134 | — | 126 | 112 | 107 | — | 377 | 303 | 73 | — | — | 51 | — | — | 44·5 | — |
| 125 | ♀ | 1170 | 169 | — | 170 | 128 | 94 | 124 | 109 *h* | 93 | 484 | 352 | 290 | — | — | — | — | — | — | — | — |
| 126 | ♂ | — | 193 | — | — | 144 | — | 136 | 116 *h* | — | — | — | 314 | — | — | — | — | — | — | — | — |
| 127 | ♀ | 1185 | 172 | 174 | 174 | 127 | 84 | 124 | 106 | 98 | 477 | 343 | 279 | 70 | 83 | 120 | 49·5 | 21 | 40·5 | 41 | 33 |
| 128 | ♀ | 1030 | 162 | 164 | 164 | 128 | 85 | 116 | 104 | 93 | 461 | 320 | 274 | 55·5 | 81 | 109 | 45 | 21·5 | 40 | 39 | 33 |
| 129 | ♂ | — | 176 | — | 177 | 136 | 98 | — | 113 *h* | — | 501 | 353 | 303 | — | — | — | — | — | — | — | — |
| 130 | ♀ | 1350 | 185 | — | 185 | 137 | 94 | 122 | 107 *h* | 95 | 512 | 364 | 290 | — | — | — | — | — | — | — | — |
| 131 | ♀ | — | 168 | 169 | 169 | 133 | 84 | 120 | 102 | 90 | 480 | 343 | 281 | 61·5 | 87 | — | 46 | 23 | 41·5 | 41·5 | 33·5 |
| 132 | ♂ | — | — | — | — | 145 | 100 | 142 | 119 | — | 525 | — | 317 | — | — | — | — | — | — | — | — |
| 133 | ♂ | — | — | — | — | 143 | 100 | — | 116 *h* | — | — | — | — | 73 | 99 | 130 | 49·5 | 22·5 | 43 | 41·5 | 33·5 |
| 134 | ♀ | 1505 | 192 | — | 192 | 144 | 95 | 127 | 115 *h* | 98 | 535 | 383 | 313 | — | — | — | — | — | — | — | — |
| 135 | ♀ | 1180 | 177 | — | 178 | 131 | 93 | 126 | 103 *h* | 99 | 495 | 342 | 275 | — | — | — | — | — | — | — | — |
| 136 | ♀ | — | 176 | — | 177 | 142 | 94 | — | 108 *h* | — | 501 | 351 | 296 | — | — | — | — | — | — | — | — |
| 137 | ♀ | — | 178 | — | 180 | 128 | 89 | — | 105 *h* | — | 492 | 354 | — | — | — | — | — | — | — | — | — |
| 138 | ♂ | 1305 | 179 | 177 | 177 | 137 | 101 | 132 | 110 | 101 | 497 | 343 | 293 | 68 | 88 | 122 | 50·5 | 25 | — | 41·5 | — |
| 139 | ♂? | — | 183 | — | 184 | 128 | 89 | — | 106 *h* | — | 497 | 363 | 274 | — | — | — | — | — | — | — | — |
| 140 | ♀ | — | 175 | — | 175 | 125 | 89 | — | 97 *h* | — | 482 | 341 | — | — | — | — | — | — | — | — | — |
| 141 | ♂ | 1445 | 179 | — | 179 | 142 | 100 | 133 | 114 | 99 | 510 | 367 | 310 | — | — | — | — | — | — | — | — |
| 142 | ♂ | — | 205 | — | 206 | 146 | 111 | 134 | 120 *h* | — | 570 | 409 | 331 | — | — | — | — | — | — | — | — |
| 143 | ♀ | — | 191 | — | 190 | 143 | 103 | 128 | 112 *h* | 99 | 538 | 378 | 301 | — | — | — | — | — | — | — | — |
| 144 | ♀ | — | 181 | — | 181 | 145 | 93 | — | 109 *h* | — | 513 | — | — | — | — | — | — | — | — | — | — |
| 145 | ♂ | 1395 | 187 | — | 187 | 140 | 97 | 127 | 113 *h* | 96 | 525 | 376 | 307 | — | — | — | — | — | — | — | — |
| 146 | ♂ | 1445 | 185 | 186 | 185 | 133 | 97 | 137 | 117 | 103 | 514 | 367 | 306 | 69 | 87 | — | 51·5 | 25·5 | 43 | — | 34 |
| 147 | ♂ | 1555 | 189 | 191 | 191 | 148 | 100 | 130 | 114 | 103 | 537 | 370 | 305 | 73 | 99 | 135 | 51·5 | 25·5 | 42 | 41·5 | 34·5 |

| $O_1$ R | $O_2$ L | $O_2$ R | Palate $G_1$ | Palate $G_2$ | Indices $B/L'$ | Indices $H/L'$ | Indices $B/L$ | Indices $H/L$ | Indices $B/H$ | Indices $G'H/GB$ | Indices $NB/NH$ | Indices $O_2/O_1$ L | Indices $O_2/O_1$ R | Indices $G_2/G_1$ | $GL$ | Angle $N\angle$ | Angle $A\angle$ | Angle $B\angle$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 43·5 | 32·5 | 33 | — | 38 | 71·4 | 69·8 | 71·4 | 69·8 | 102·3 | — | 55·4 | 75·6 | 75·9 | — | — | — | — | — | |
| — | — | — | — | — | — | — | 76·9 | — | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 71·7 | 73·3 | 97·7 | — | — | — | — | — | — | — | — | — | |
| — | — | — | 49 | 34 | — | — | 71·3 | 68·1 | 104·8 | 89·9 | 40·4 | — | — | 69·4 | 95 | 64°·5 | 73° | 42°·5 | |
| — | — | — | — | — | — | — | 74·5 | 67·7 | 110 | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 73·9 | 67·2 | 109·9 | — | — | — | — | — | — | — | — | — | |
| 42 | 35·5 | 34·5 | 44·5 | 30 | 77·9 | 69·2 | 78·4 | 69·6 | 112·6 | 84·3 | 47·5 | 84·5 | 82·1 | 67·4 | 83 | 62° | 70°·5 | 47°·5 | 1 |
| — | — | — | — | — | — | — | 72·7 | — | — | — | — | — | — | — | — | — | — | — | |
| 38·5 | 32·5 | 33 | — | 36·5 | 73·2 | 63·7 | 73·2 | 63·7 | 114·9 | 77·5 | 52·7 | — | 85·7 | — | 90 | 62° | 80° | 38° | 1 |
| — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | 65·8 | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 70·8 | — | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | 70·2 | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 76·2 | 68·6 | 111 | — | — | — | — | — | — | — | — | — | |
| 41 | 35 | 34·5 | 47 | 40 | 72·8 | 67·2 | 72·4 | 66·8 | 108·2 | 82·9 | 46·2 | 85·4 | 84·1 | 85·1 | 95 | 64°·5 | 73°·5 | 42° | 1 |
| — | — | — | — | — | — | — | 77·8 | 80 | 97·2 | — | — | — | — | — | — | — | — | — | |
| — | — | — | 45 | 36·5 | — | — | — | — | — | — | — | — | — | 81·1 | 92·5 | — | — | — | |
| — | — | — | — | — | — | — | 74·2 | 68·3 | 108·7 | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 80·7 | — | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 76·2 | 66·8 | 114 | — | — | — | — | — | — | — | — | — | |
| 44·5 | 31·5 | 30·5 | 48 | 37·5 | 74·6 | 74 | 75 | 74·5 | 100·7 | 65·9 | 66 | 71·6 | 68·5 | 78·1 | 91·5 | 67° | 72°·5 | 40°·5 | 9 |
| 42 | 35 | 34·5 | 45 | 34·5? | 70·3 | 66·5 | 70·7 | 66·8 | 105·8 | 80·6 | 49·5 | 82·3 | 82·1 | 76·7 | 93·5 | 65° | 73°·5 | 41°·5 | 9 |
| — | 31 | — | — | — | — | — | 73·1 | 69·9 | 104·6 | — | — | 74·7 | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 70 | 70·6 | 99·3 | — | — | — | — | — | — | — | — | — | |
| 44·5 | — | 37·5 | — | — | 69·1 | 64·9 | 68·7 | 64·6 | 106·4 | — | — | — | 84·3 | — | 95·5 | 60°·5 | 78° | 41°·5 | 1 |
| — | — | — | — | — | — | — | 75·3 | 72·9 | 103·2 | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 105·9 | — | — | — | — | — | — | — | — | — | |
| 41 | 33 | 34 | 45 | 35 | 73 | 71·3 | 73 | 71·3 | 102·4 | 84·3 | 42·4 | 81·5 | 82·9 | 77·8 | 90·5 | 63° | 74° | 43° | 1 |
| 39 | 33 | 33 | 42? | 35? | 78 | 70·7 | 78 | 70·7 | 110·4 | 68·5 | 47·8 | 82·5 | 84·6 | 83·3 | 89 | 68° | 76° | 36° | 1 |
| — | — | — | — | — | — | — | 76·8 | — | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 74 | 65·9 | 112·3 | — | — | — | — | — | — | — | — | — | |
| 41·5 | 33·5 | 33 | — | 33? | 78·7 | 71 | 78·7 | 71 | 110·9 | 70·7 | 50 | 80·7 | 79·5 | — | 85·5 | 65°·5 | 73°·5 | 41° | |
| — | — | — | 52 | 36·5 | — | — | — | — | 102·1 | — | — | — | — | 70·2 | 89 | — | — | — | |
| 41·5 | 33·5 | 33·5 | 47·5 | 35 | — | — | — | — | — | 73·7 | 45·4 | 77·9 | 80·7 | 73·7 | — | — | — | — | |
| — | — | — | — | — | — | — | 75 | 66·1 | 113·4 | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 73·6 | 70·8 | 103·9 | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 80·2 | — | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 71·1 | — | — | — | — | — | — | — | — | — | — | — | |
| 41·5 | — | 30·5 | 47 | 35·5 | 77·4 | 74·6 | 77·4 | 74·6 | 103·8 | 77·3 | 49·5 | — | 73·5 | 75·5 | 94·5 | 64°·5 | 75° | 40°·5 | 2 |
| — | — | — | — | — | — | — | 69·6 | — | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 71·4 | — | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 79·3 | 74·3 | 106·7 | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 70·9 | 65 | 108·9 | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 75·3 | 67·4 | 111·7 | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 80·1 | — | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | 74·9 | 67·9 | 110·2 | — | — | — | — | — | — | — | — | — | |
| — | 34 | — | 44·5 | 36 | 71·5 | 73·7 | 71·9 | 74 | 97·1 | 79·3 | 49·5 | 79·1 | — | 80·9 | 94 | 62°·5 | 77° | 40°·5 | 1 |
| 41·5 | 34·5 | 35 | 47·5 | ·36 | 77·5 | 68·1 | 77·5 | 68·1 | 113·9 | 73·7 | 49·5 | 82·1 | 84·3 | 75·8 | 96 | 63°·5 | 74° | 42°·5 | 1 |

# MEASUREMENTS OF SEVENTEENTH CENTURY ENGLISH CRANIA.

| Face | | | | | Palate | | Indices | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $O_1$ | | $O_2$ | | | | | | | | | | | | | | | |
| *NB* | *L* | *R* | *L* | *R* | $G_1$ | $G_2$ | *B/L'* | *H/L'* | *B/L* | *H/L* | *B/H* | *G'H/GB* | *NB/NH* | $O_2/O_1$ *L* | $O_2/O_1$ *R* | $G_2/G_1$ | *GL* | *N* |
| 25·5 | 43 | 43·5 | 32·5 | 33 | — | 38 | 71·4 | 69·8 | 71·4 | 69·8 | 102·3 | — | 55·4 | 75·6 | 75·9 | — | — | |
| — | — | — | — | — | — | — | — | — | 76·9 | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 71·7 | 73·3 | 97·7 | — | — | — | — | — | — | |
| 20 | — | — | — | — | 49 | 34 | — | — | 71·3 | 68·1 | 104·8 | 89·9 | 40·4 | — | — | 69·4 | 95 | 64 |
| — | — | — | — | — | — | — | — | — | 74·5 | 67·7 | 110 | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 73·9 | 67·2 | 109·9 | — | — | — | — | — | — | |
| 23·5 | 42 | 42 | 35·5 | 34·5 | 44·5 | 30 | 77·9 | 69·2 | 78·4 | 69·6 | 112·6 | 84·3 | 47·5 | 84·5 | 82·1 | 67·4 | 83 | 62 |
| — | — | — | — | — | — | — | — | — | 72·7 | — | — | — | — | — | — | — | — | |
| 24 | — | 38·5 | 32·5 | 33 | — | 36·5 | 73·2 | 63·7 | 73·2 | 63·7 | 114·9 | 77·5 | 52·7 | — | 85·7 | — | 90 | 62 |
| — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | — | 65·8 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 70·8 | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | — | 70·2 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 76·2 | 68·6 | 111 | — | — | — | — | — | — | |
| 24·5 | 41 | 41 | 35 | 34·5 | 47 | 40 | 72·8 | 67·2 | 72·4 | 66·8 | 108·2 | 82·9 | 46·2 | 85·4 | 84·1 | 85·1 | 95 | 6 |
| — | — | — | — | — | — | — | — | — | 77·8 | 80 | 97·2 | — | — | — | — | — | — | |
| — | — | — | — | — | 45 | 36·5 | — | — | — | — | — | — | — | — | — | 81·1 | 92·5 | |
| — | — | — | — | — | — | — | — | — | 74·2 | 68·3 | 108·7 | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 80·7 | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 76·2 | 66·8 | 114 | — | — | — | — | — | — | |
| 33 | 44 | 44·5 | 31·5 | 30·5 | 48 | 37·5 | 74·6 | 74 | 75 | 74·5 | 100·7 | 65·9 | 66 | 71·6 | 68·5 | 78·1 | 91·5 | 6 |
| 24·5 | 42·5 | 42 | 35 | 34·5 | 45 | 34·5? | 70·3 | 66·5 | 70·7 | 66·8 | 105·8 | 80·6 | 49·5 | 82·3 | 82·1 | 76·7 | 93·5 | 6 |
| — | 41·5 | — | 31 | — | — | — | — | — | 73·1 | 69·9 | 104·6 | — | — | 74·7 | — | — | — | |
| — | — | — | — | — | — | — | — | — | 70 | 70·6 | 99·3 | — | — | — | — | — | — | |
| — | — | 44·5 | — | 37·5 | — | — | 69·1 | 64·9 | 68·7 | 64·6 | 106·4 | — | — | — | 84·3 | — | 95·5 | 6 |
| — | — | — | — | — | — | — | — | — | 75·3 | 72·9 | 103·2 | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | — | — | 105·9 | — | — | — | — | — | — | |
| 21 | 40·5 | 41 | 33 | 34 | 45 | 35 | 73 | 71·3 | 73 | 71·3 | 102·4 | 84·3 | 42·4 | 81·5 | 82·9 | 77·8 | 90·5 | 6 |
| 21·5 | 40 | 39 | 33 | 33 | 42? | 35? | 78 | 70·7 | 78 | 70·7 | 110·4 | 68·5 | 47·8 | 82·5 | 84·6 | 83·3 | 89 | 6 |
| — | — | — | — | — | — | — | — | — | 76·8 | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 74 | 65·9 | 112·3 | — | — | — | — | — | — | |
| 23 | 41·5 | 41·5 | 33·5 | 33 | — | 33? | 78·7 | 71 | 78·7 | 71 | 110·9 | 70·7 | 50 | 80·7 | 79·5 | — | 85·5 | 6 |
| — | — | — | — | — | 52 | 36·5 | — | — | — | — | 102·1 | — | — | — | — | 70·2 | 89 | |
| 22·5 | 43 | 41·5 | 33·5 | 33·5 | 47·5 | 35 | — | — | — | — | — | 73·7 | 45·4 | 77·9 | 80·7 | 73·7 | — | |
| — | — | — | — | — | — | — | — | — | 75 | 66·1 | 113·4 | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 73·6 | 70·8 | 103·9 | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 80·2 | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 71·1 | — | — | — | — | — | — | — | — | |
| 25 | — | 41·5 | — | 30·5 | 47 | 35·5 | 77·4 | 74·6 | 77·4 | 74·6 | 103·8 | 77·3 | 49·5 | — | 73·5 | 75·5 | 94·5 | 6 |
| — | — | — | — | — | — | — | — | — | 69·6 | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 71·4 | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 79·3 | 74·3 | 106·7 | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 70·9 | 65 | 108·9 | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 75·3 | 67·4 | 111·7 | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 80·1 | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 74·9 | 67·9 | 110·2 | — | — | — | — | — | — | |
| 25·5 | 43 | — | 34 | — | 44·5 | 36 | 71·5 | 73·7 | 71·9 | 74 | 97·1 | 79·3 | 49·5 | 79·1 | — | 80·9 | 94 | |
| 25·5 | 42 | 41·5 | 34·5 | 35 | 47·5 | 36 | 77·5 | 68·1 | 77·5 | 68·1 | 113·9 | 73·7 | 49·5 | 82·1 | 84·3 | 75·8 | 96 | |

# TABLE III.

| | | Angles | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| $G_2/G_1$ | $GL$ | $N\angle$ | $A\angle$ | $B\angle$ | $\theta_2$ | $\theta_1$ | $P\angle$ | |
| — | — | — | — | — | — | — | — | cal. y. ad. left mastoid defect. slight post coronal constriction [asterion |
| — | — | — | — | — | — | — | — | cal. – f. ad. centre of base defective. left ossicle of |
| — | — | — | — | — | — | — | — | cal. – f. ad. small l. occipital defect |
| 69·4 | 95 | 64°·5 | 73° | 42°·5 | — | — | — | cal. y. ad. both malar regions defective |
| — | — | — | — | — | — | — | — | cal. – f. ad. ethmoidal and small l. occipital defect |
| — | — | — | — | — | — | — | — | cal. – f. y. ad. ossicle in forepart of squamous suture r. |
| 67·4 | 83 | 62° | 70°·5 | 47°·5 | 16°·5 | 31° | 87° | cal. y. ad. metopic |
| — | — | — | — | — | — | — | — | cal. – f. y. ad. large occipital, r. temporal and ethmoidal defects. metopic. small ossicle of λ. 1 × 1 cm. |
| — | 90 | 62° | 80° | 38° | 15° | 23° | 95° | cal. old? l. temporal and r. zygoma defective. paired precondylar eminences. slight post coronal constriction |
| — | — | — | — | — | — | — | — | dome. ad. metopic [precondylar eminences |
| — | — | — | — | — | — | — | — | cal. – f. ad. several defects. slight median and paired |
| — | — | — | — | — | — | — | — | dome. ad. |
| — | — | — | — | — | — | — | — | cal. – f. ad. with large defect, forepart of base. anterior extremities of condyles united by osseous bridge: see reproduction |
| — | — | — | — | — | — | — | — | cal. – f. old. base very defective |
| — | — | — | — | — | — | — | — | cal. – f. y. ad. with r. temporo-sphenoidal defect. small ossicle of pterion on l. |
| 85·1 | 95 | 64°·5 | 73°·5 | 42° | 16°·5 | 25°·5 | 90° | cal. ad. defective l. zygoma |
| — | — | — | — | — | — | — | — | cal. – f. ad. slight depression of obelion |
| 81·1 | 92·5 | — | — | — | — | — | — | cal. ad. r. temporal defect |
| — | — | — | — | — | — | — | — | cal. – f. ad. base very defective |
| — | — | — | — | — | — | — | — | cal. – f. ad. central defect in base. two ossicles in r. end of lambdoid suture |
| — | — | — | — | — | — | — | — | cal. – f. ad. |
| 78·1 | 91·5 | 67° | 72°·5 | 40°·5 | 9°·5 | 31° | 82° | cal. ad. infra-orbital suture on face, both sides |
| 76·7 | 93·5 | 65° | 73°·5 | 41°·5 | 9°·5 | 32° | 83° | cal. old. defective r. zygomatic arch. post coronal constriction. paired precondylar eminences, left larger |
| — | — | — | — | — | — | — | — | cal. y. ad. r. temporo-frontal and r. half face missing. l. *porus crotaphitico-buccinatorius* (Hyrtl) |
| — | — | — | — | — | — | — | — | cal. – f. ad. |
| — | 95·5 | 60°·5 | 78° | 41°·5 | 12° | 29°·5 | 90° | cal. old. l. side face and frontal defective. slight post coronal constriction |
| — | — | — | — | — | — | — | — | cal. – f. y. ad. |
| — | — | — | — | — | — | — | — | cal. – f. ad. forepart base defective |
| 77·8 | 90·5 | 63° | 74° | 43° | 14° | 29° | 88° | cal. ad. [*cinatorius* |
| 83·3 | 89 | 68° | 76° | 36° | 10° | 26° | 86° | cal. old. *torus occipitalis, incissura crotaphitico-buc-* |
| — | — | — | — | — | — | — | — | cal. – f. ad. central part base defective |
| — | — | — | — | — | — | — | — | cal. – f. y. ad. [defects |
| — | 85·5 | 65°·5 | 73°·5 | 41° | 9°·5 | 31°·5 | 83° | cal. ad. occipital, slight r. temporal and l. zygomata |
| 70·2 | 89 | — | — | — | — | — | — | cal. y. ad. face very defective |
| 73·7 | — | — | — | — | — | — | — | cal. ad. occipital and l. temporal defects |
| — | — | — | — | — | — | — | — | cal. – f. ad. slight l. parietal defect. slight bathrocephaly. r. precondylar eminence |
| — | — | — | — | — | — | — | — | cal. – f. y. ad. two ossicles r. end of lambdoid suture, each 15 × 10 mm. |
| — | — | — | — | — | — | — | — | cal. – f. ad. defective base |
| — | — | — | — | — | — | — | — | dome. ad. |
| 75·5 | 94·5 | 64°·5 | 75° | 40°·5 | 7° | 33°·5 | 82° | cal. ad. defect. l. maxillary. metopic |
| — | — | — | — | — | — | — | — | cal. – f. ad. defective base |
| — | — | — | — | — | — | — | — | dome. y. ad. |
| — | — | — | — | — | — | — | — | cal. – f. ad. metopic; metopic fontanelle. wormian 26 × 8 mm. hinder end squamous suture |
| — | — | — | — | — | — | — | — | cal. – f. old. fracture of base |
| — | — | — | — | — | — | — | — | cal. – f. y. ad. spheno-ethmoidal defect. r. ossicle of pterion. faint post coronal constriction |
| — | — | — | — | — | — | — | — | dome. ad. slight depression of obelion |
| — | — | — | — | — | — | — | — | cal. – f. ad. [lambdoid suture |
| 80·9 | 94 | 62°·5 | 77° | 40°·5 | 11° | 29°·5 | 88° | cal. y. ad. right malar defect. some wormians in |
| 75·8 | 96 | 63°·5 | 74° | 42°·5 | 18° | 24°·5 | 92° | cal. ad. ossicle in fore part r. squamous suture. alisphenoid produced upwards |

| | | | Lengths | | | | | | | | Circumferences | | | Face | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Series No. | Sex | *C* | *F* | *L'* | *L* | *B* | *B'* | *H* | *OH* | *LB* | *U* | *S* | *Q* | *G'H* | *GB* | *J* | *NH* | *NB* | $O_1$ *L* | $O_1$ *R* | $O_2$ *L* | $O_2$ |
| 148 | ♂ | — | 198 | — | 200 | 140 | 102 | 129 | 117 *h* | 102 | 542 | 390 | 320 | — | — | — | — | — | — | — | — | |
| 149 | ♀ | 1315 | 184 | 185 | 185 | 138 | 94 | 121 | 107 | 98 | 513 | 367 | 294 | 68 | 83 | 117 | 46·5 | 21·5 | 41 | 40·5 | 34 | |
| 150 | ♀ | — | 176 | 175 | 175 | 135 | 97 | 127 | 110 | 95 | 500 | 328 | 295 | 62 | 82 | — | 46 | 22 | 41 | 40·5 | 33·5 | |
| 151 | ♂? | — | 189 | — | 190 | 143 | 91 | 132 | 114 *h* | 102 | 527 | 378 | 308 | — | — | — | — | — | — | — | — | |
| 152 | ♀ | — | 185 | — | 185 | 140 | 96 | 126 | 114 *h* | 95 | 517 | 380 | 309 | — | — | — | — | — | — | — | — | |
| 153 | ♂ | 1400 | 187 | — | 187 | 140 | 98 | 129 | 117 *h* | 98 | 525 | 379 | 310 | — | — | — | — | — | — | — | — | |
| 154 | ♂ | — | 196 | — | 199 | 139 | 100 | 141 | 122 *h* | 111 | 537 | 390 | — | 72·5 | — | — | 52·5 | 24 | 44 | — | 36·5 | |
| 155 | ♀ | — | 183? | — | 183? | 134 | 86 | — | 110 *h* | — | 508 | 378 | — | — | — | — | — | — | — | — | — | |
| 156 | ♂ | 1410 | 185 | — | 185 | 139 | 93 | 140 | 125 *h* | 102 | 517 | 380 | 322 | — | — | — | — | — | — | — | — | |
| 157 | ♂ | 1580 | 192 | — | 195 | 144 | 101 | 141 | 124 *h* | 99 | 541 | 405 | 323 | — | — | — | — | — | — | — | — | |
| 158 | ♀ | 1315 | 182 | — | 183 | 135 | 93 | 130 | 116 *h* | 97 | 509 | 373 | 305 | — | — | — | — | — | — | — | — | |
| 159 | ♀ | — | 186 | — | 186 | — | 103 | 127 | 110 *h* | 100 | 519 | 363 | — | 74 | 89 | — | 51 | 24·5 | 41 | 41 | 36·5 | |
| 160 | ♂ | — | 190 | 192 | 192 | 138 | 95 | 130 | 111 | 105 | 523 | 378 | 298 | 70 | — | — | 54·5 | — | — | — | — | |
| 161 | ♂ | 1465 | 187 | 188 | 188 | 146 | 104 | 135 | 115 | 104 | 532 | 380 | 313 | 71·5 | 96 | 140 | 52 | 25·5 | 47 | 47 | 35 | |
| 162 | ♂? | 1435 | 189 | 190 | 191 | 142 | 93 | 131 | 113 | 107 | 524 | 365 | 297 | — | — | 125 | — | — | — | 40·5 | — | |
| 163 | ♂ | — | 190 | 190 | 190 | 153 | 97 | — | 114 | 103 | 535 | — | — | 71 | 87 | 139 | 50 | 26 | 44 | 44·5 | 33 | |
| 164 | ♀ | — | 184 | — | 184 | 129 | 90 | — | 109 *h* | — | 508 | 373 | 292 | — | — | — | — | — | — | — | — | |
| 165 | ♀? | — | 180 | — | 181 | 136 | 94 | — | 104 *h* | — | 500 | 355 | — | — | — | — | — | — | — | — | — | |
| 166 | ♀ | — | 181 | — | 181 | 132 | 90 | 124 | 109 *h* | 92 | 500 | 370 | — | — | — | — | — | — | — | 38 | — | |
| 167 | ♀ | 1370 | 184 | 184 | 183 | 136 | 96 | 127 | 114 | 103 | 511 | 364 | 297 | — | — | 122 | — | — | — | 42 | 35 | |
| 168 | ♂ | — | — | — | — | 148 | — | — | 115 *h* | — | — | — | 322 | — | — | — | — | — | — | — | — | |
| 169 | ♂ | — | 191 | — | 192 | 142 | 96 | — | — | — | 530 | 370 | — | — | — | — | — | — | — | — | — | |
| 170 | ♀ | 1140 | 176 | — | 177 | 132 | 95 | 122 | 103 *h* | 92 | 491 | 352 | 271 | — | — | — | — | — | — | — | — | |
| 171 | ♂ | — | 180 | — | 185 | 133 | 91 | — | 110 *h* | — | 505 | 364 | — | — | — | — | — | — | — | — | — | |
| 172 | ♂ | 1495 | 192 | 193 | 193 | 140 | 103 | 130 | 114 | 107 | 526 | 373 | 303 | 71 | — | — | 51 | 25 | 43 | 43 | 33 | |
| 173 | ♂ | — | 186 | — | 187 | 141 | 99 | 134 | 118 *h* | 107 | 522 | 383 | 308 | — | — | — | — | — | — | — | — | |
| 174 | ♂ | 1665 | 195 | — | 196 | 145 | 106 | 137 | 117 *h* | 102 | 545 | 394 | 318 | — | — | 134 | — | — | — | — | — | |
| 175 | ♂ | 1470 | 188 | 190 | 190 | 148 | 100 | 130 | 114 | 105 | 535 | 369 | 314 | 71·5 | 92 | — | 56·5 | 29 | 43·5 | 45 | 35·5 | |
| 176 | ♂ | — | 184 | — | 185 | 139 | 100 | 122 | 109 *h* | 105 | 516 | 353 | — | — | — | — | — | — | — | — | — | |
| 177 | ♀ | 1265 | 177 | — | 179 | 137 | 93 | 127 | 113 *h* | 94 | 496 | 362 | 300 | — | — | — | — | — | — | — | — | |
| 178 | ♂? | — | 190 | — | 191 | 139 | 98 | — | — | — | 525 | 369 | — | — | — | — | — | — | — | — | — | |
| 179 | ♂ | — | 185 | — | 188 | 136 | — | 125 | 112 *h* | 103 | — | 360 | — | 68·5 | 89 | 125 | 51 | 25·5 | 43 | — | 34·5 | |
| 180 | ♀ | 1215 | 176 | 176 | 177 | 129 | — | 122 | 105 | 93 | 486 | 355 | 280 | 71·5 | 81 | — | 51·5 | 23 | 40 | — | 32·5 | |
| 181 | ♀ | — | 175 | — | 175 | — | 94 | 118 | 102 *h* | 93 | — | 342 | — | 60? | — | — | 47·5 | — | 42 | — | 34·5 | |
| 182 | ♂? | 1260 | 178 | — | 181 | 137 | 97 | 119 | 107 *h* | 100 | 505 | 351 | 288 | — | — | — | — | — | — | — | — | |
| 183 | ♀ | 1295 | 183 | — | 183 | 131 | 89 | 121 | 107 *h* | 93 | 502 | 365 | 295 | — | — | — | — | — | — | — | — | |
| 184 | ♀ | 1180 | 176 | — | 177 | 132 | 85 | 117 | 107 *h* | 92 | 486 | 343 | 281 | — | — | — | — | — | — | — | — | |
| 185 | ♂ | — | 193 | — | 195 | 141 | 103 | 129 | 117 *h* | 97 | 540 | 392 | 312 | — | — | 136 | — | — | — | — | — | |
| 186 | ♀? | — | 181 | — | 181 | 135 | 98 | — | 110 *h* | — | 511 | 361 | — | — | — | — | — | — | — | — | — | |
| 187 | ♂ | — | 185 | — | 189 | 140 | 95 | 134 | 119 *h* | 100 | 518 | 378 | — | 76 | 91 | — | 52 | 25·5 | 45 | 44·5 | 35 | |
| 188 | ♂ | — | 185 | 184 | 185 | 139 | 90 | 135 | 113 | 100 | 518 | 377 | 305 | 70 | 90 | 124 | 52 | — | — | 40·5 | — | |

| $O_1$ R | $O_2$ L | $O_2$ R | Palate $G_1$ | Palate $G_2$ | Indices $B/L'$ | Indices $H/L'$ | Indices $B/L$ | Indices $H/L$ | Indices $B/H$ | Indices $G'H/GB$ | Indices $NB/NH$ | Indices $O_2/O_1$ L | Indices $O_2/O_1$ R | Indices $G_2/G_1$ | Indices $GL$ | Indices $N\angle$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| — | — | — | — | — | — | — | 70 | 64·5 | 108·6 | — | — | — | — | — | — | — |
| 40·5 | 34 | 34 | 47·5 | 35? | 74·6 | 65·4 | 74·6 | 65·4 | 114 | 81·9 | 46·2 | 82·9 | 83·9 | 73·7 | 94·5 | 66°·5 |
| 40·5 | 33·5 | 33·5 | 46·5 | 36 | 77·1 | 72·6 | 77·1 | 72·6 | 106·3 | 75·6 | 47·8 | 81·7 | 82·7 | 77·4 | 91 | 67° |
| — | — | — | — | — | — | — | 75·3 | 69·5 | 108·3 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 75·7 | 68·1 | 111·1 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 74·9 | 69 | 108·6 | — | — | — | — | — | — | — |
| — | 36·5 | — | 54 | 36 | — | — | 69·8 | 70·8 | 98·6 | — | 45·7 | 82·9 | — | 66·7 | 105 | 66° |
| — | — | — | — | — | — | — | 73·2 | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 75·1 | 75·7 | 99·3 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 73·8 | 72·3 | 102·1 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 73·8 | 71 | 103·8 | — | — | — | — | — | — | — |
| 41 | 36·5 | 37 | 54 | 35 | — | — | — | 68·3 | — | 83·1 | 48 | 89 | 90·2 | 64·8 | 100 | 68°·5 |
| — | — | — | 43 | 30·5? | 71·9 | 67·7 | 71·9 | 67·7 | 106·1 | — | — | — | — | 70·9 | 96 | 63° |
| 47 | 35 | 34·5 | 47·5 | 36·5 | 77·7 | 71·8 | 77·7 | 71·8 | 108·1 | 74·5 | 49 | 74·5 | 73·4 | 76·8 | 97 | 64° |
| 40·5 | — | 32 | — | — | 74·7 | 68·9 | 74·3 | 68·6 | 108·4 | — | — | — | 79 | — | — | — |
| 44·5 | 33 | 31·5 | 50·5 | 41·5 | 80·5 | — | 80·5 | — | — | 81·6 | 52 | 75 | 70·8 | 82·2 | 101·5 | 68°·5 |
| — | — | — | — | — | — | — | 70·1 | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 75·1 | — | — | — | — | — | — | — | — | — |
| 38 | — | 36·5 | — | — | — | — | 72·9 | 68·5 | 106·5 | — | — | — | 96 | — | — | — |
| 42 | 35 | 33 | — | — | 73·9 | 69 | 74·3 | 69·4 | 107·1 | — | — | — | 78·6 | — | — | — |
| — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 74 | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 74·6 | 68·9 | 108·2 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 71·9 | — | — | — | — | — | — | — | — | — |
| 43 | 33 | 34·5 | 49? | 37·5 | 72·5 | 67·4 | 72·5 | 67·4 | 107·6 | — | 49 | 76·7 | 80·2 | 76·5 | 105·5 | 69° |
| — | — | — | — | — | — | — | 75·4 | 71·7 | 105·3 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 74 | 69·9 | 105·8 | — | — | — | — | — | — | — |
| 45 | 35·5 | 35 | 43·5 | — | 77·9 | 68·4 | 77·9 | 68·4 | 113·9 | 77·7 | 51·3 | 81·6 | 77·8 | — | 92·5 | 59°·5 |
| — | — | — | — | — | — | — | 75·1 | 65·9 | 113·9 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 76·5 | 70·9 | 107·9 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 72·8 | — | — | — | — | — | — | — | — | — |
| — | 34·5 | — | 49 | 38 | — | — | 72·3 | 66·5 | 108·8 | 77 | 50 | 80·2 | — | 77·5 | 98 | 66° |
| — | 32·5 | — | 40 | 33 | 73·3 | 69·3 | 72·9 | 68·9 | 105·7 | 88·3 | 44·7 | 81·2 | — | 82·5 | 85 | 60°·5 |
| — | 34·5 | — | 39? | — | — | — | — | 67·4 | — | — | — | 82·1 | — | — | 79 | 57° |
| — | — | — | — | — | — | — | 75·7 | 65·7 | 115·1 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 71·6 | 66·1 | 108·2 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 74·6 | 66·1 | 112·9 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 72·3 | 66·1 | 109·3 | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | 74·6 | — | — | — | — | — | — | — | — | — |
| 44·5 | 35 | 36 | 50·5 | 36·5 | — | — | 74·1 | 70·9 | 104·5 | 83·5 | 49 | 77·8 | 80·9 | 72·3 | 102 | 69° |
| 40·5 | — | 35 | 46 | 35 | 75·5 | 73·4 | 75·1 | 73 | 103 | 77·8 | — | — | 86·4 | 76·1 | 87·5 | 59° |

## MEASUREMENTS OF SEVENTEENTH CENTURY ENGLISH CRANIA.

| ce | | | | | Palate | | Indices | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | $O_1$ L | $O_1$ R | $O_2$ L | $O_2$ R | $G_1$ | $G_2$ | B/L′ | H/L′ | B/L | H/L | B/H | G′H/GB | NB/NH | $O_2/O_1$ L | $O_2/O_1$ R | $G_2/G_1$ | GL |
| | — | — | — | — | — | — | — | — | 70 | 64·5 | 108·6 | — | — | — | — | — | — |
| 5 | 41 | 40·5 | 34 | 34 | 47·5 | 35? | 74·6 | 65·4 | 74·6 | 65·4 | 114 | 81·9 | 46·2 | 82·9 | 83·9 | 73·7 | 94·5 |
| | 41 | 40·5 | 33·5 | 33·5 | 46·5 | 36 | 77·1 | 72·6 | 77·1 | 72·6 | 106·3 | 75·6 | 47·8 | 81·7 | 82·7 | 77·4 | 91 |
| | — | — | — | — | — | — | — | — | 75·3 | 69·5 | 108·3 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 75·7 | 68·1 | 111·1 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 74·9 | 69 | 108·6 | — | — | — | — | — | — |
| | 44 | — | 36·5 | — | 54 | 36 | — | — | 69·8 | 70·8 | 98·6 | — | 45·7 | 82·9 | — | 66·7 | 105 |
| | — | — | — | — | — | — | — | — | 73·2 | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 75·1 | 75·7 | 99·3 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 73·8 | 72·3 | 102·1 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 73·8 | 71 | 103·8 | — | — | — | — | — | — |
| 5 | 41 | 41 | 36·5 | 37 | 54 | 35 | — | — | — | 68·3 | — | 83·1 | 48 | 89 | 90·2 | 64·8 | 100 |
| | — | — | — | — | 43 | 30·5? | 71·9 | 67·7 | 71·9 | 67·7 | 106·1 | — | — | — | — | 70·9 | 96 |
| 5 | 47 | 47 | 35 | 34·5 | 47·5 | 36·5 | 77·7 | 71·8 | 77·7 | 71·8 | 108·1 | 74·5 | 49 | 74·5 | 73·4 | 76·8 | 97 |
| | — | 40·5 | — | 32 | — | — | 74·7 | 68·9 | 74·3 | 68·6 | 108·4 | — | — | — | 79 | — | — |
| | 44 | 44·5 | 33 | 31·5 | 50·5 | 41·5 | 80·5 | — | 80·5 | — | — | 81·6 | 52 | 75 | 70·8 | 82·2 | 101·5 |
| | — | — | — | — | — | — | — | — | 70·1 | — | — | — | — | — | — | — | — |
| | — | 38 | — | 36·5 | — | — | — | — | 75·1 | — | — | — | — | — | — | — | — |
| | — | 42 | 35 | 33 | — | — | 73·9 | 69 | 72·9 | 68·5 | 106·5 | — | — | — | 96 | — | — |
| | — | — | — | — | — | — | — | — | 74·3 | 69·4 | 107·1 | — | — | — | 78·6 | — | — |
| | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 74 | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 74·6 | 68·9 | 108·2 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 71·9 | — | — | — | — | — | — | — | — |
| | 43 | 43 | 33 | 34·5 | 49? | 37·5 | 72·5 | 67·4 | 72·5 | 67·4 | 107·6 | — | 49 | 76·7 | 80·2 | 76·5 | 105·5 |
| | — | — | — | — | — | — | — | — | 75·4 | 71·7 | 105·3 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 74 | 69·9 | 105·8 | — | — | — | — | — | — |
| | 43·5 | 45 | 35·5 | 35 | 43·5 | — | 77·9 | 68·4 | 77·9 | 68·4 | 113·9 | 77·7 | 51·3 | 81·6 | 77·8 | — | 92·5 |
| | — | — | — | — | — | — | — | — | 75·1 | 65·9 | 113·9 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 76·5 | 70·9 | 107·9 | — | — | — | — | — | — |
| 5 | 43 | — | 34·5 | — | 49 | 38 | — | — | 72·8 | — | — | — | — | — | — | — | — |
| | 40 | — | 32·5 | — | 40 | 33 | 73·3 | 69·3 | 72·3 | 66·5 | 108·8 | 77 | 50 | 80·2 | — | 77·5 | 98 |
| | 42 | — | 34·5 | — | 39? | — | — | — | 72·9 | 68·9 | 105·7 | 88·3 | 44·7 | 81·2 | — | 82·5 | 85 |
| | — | — | — | — | — | — | — | — | — | 67·4 | — | — | — | 82·1 | — | — | 79 |
| | — | — | — | — | — | — | — | — | 75·7 | 65·7 | 115·1 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 71·6 | 66·1 | 108·2 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 74·6 | 66·1 | 112·9 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 72·3 | 66·1 | 109·3 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 74·6 | — | — | — | — | — | — | — | — |
| 5 | 45 | 44·5 | 35 | 36 | 50·5 | 36·5 | — | — | 74·1 | 70·9 | 104·5 | 83·5 | 49 | 77·8 | 80·9 | 72·3 | 102 |
| | — | 40·5 | — | 35 | 46 | 35 | 75·5 | 73·4 | 75·1 | 73 | 103 | 77·8 | — | — | 86·4 | 76·1 | 87·5 |

## TABLE IV.

| | | | Angles | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | $G_2/G_1$ | $GL$ | $N\angle$ | $A\angle$ | $B\angle$ | $\theta_2$ | $\theta_1$ | $P\angle$ | |
| | — | — | — | — | — | — | — | — | cal. – f. ad. r. temporal defect. aperture in r. frontal 15 × 15 mm. with sloping smooth cicatrized margin probably result of separation of sequestrum due to injury [*tinus* |
| | 73·7 | 94·5 | 66°·5 | 72° | 41°·5 | 15° | 26°·5 | 87° | cal. ad. faint post coronal constriction, *torus pala-* |
| | 77·4 | 91 | 67° | 74° | 39° | 9° | 30° | 83° | cal. y. ad. occipital defects; apex of occipital squama produced. wormians in lambdoid suture |
| | — | — | — | — | — | — | — | — | cal. – f. ad. ethmoidal and temporal defects |
| | — | — | — | — | — | — | — | — | cal. – f. ad. l. temporal defect. occipital squama prolonged upwards |
| | — | — | — | — | — | — | — | — | cal. – f. ad. small occipital defect [ × 33 longit. mm. |
| | 66·7 | 105 | 66° | 75° | 39° | — | — | — | cal. ad. large defects on r. side. ossicle of λ. 50 trans. |
| | — | — | — | — | — | — | — | — | cal. – f. y. ad. r. temporal defect and base fractured. slight post coronal depression. ossicles in l. lambdoid suture. persistent frontal suture, 3 cms. |
| | — | — | — | — | — | — | — | — | cal. – f. ad. *torus occipitalis* |
| | — | — | — | — | — | — | — | — | cal. – f. old? some bathrocephaly |
| | — | — | — | — | — | — | — | — | cal. – f. ad. slight depression of obelion. faint post coronal constriction |
| 2 | 64·8 | 100 | 68°·5 | 68°·5 | 43° | — | — | — | cal. y. ad. large temporal defects. faint post coronal depression. ossicle of pterion bilateral. ossicle in l. lambdoid suture and small one in r. |
| | 70·9 | 96 | 63° | 76°·5 | 40°·5 | — | — | — | cal. ad. face very defective. post coronal depression |
| 4 | 76·8 | 97 | 64° | 75° | 41° | 12° | 29° | 87° | cal. ad. slight temporal defect. l. third molar erupting. median prominence 7 mm. wide, 4 mm. high at anterior margin of *foramen magnum* (? third condyle) |
| | — | — | — | — | — | — | — | — | cal. – f. + r. orbit. ad. wormians in outer part of l. lambdoid suture |
| 8 | 82·2 | 101·5 | 68°·5 | 71° | 40°·5 | 15° | 25°·5 | 86° | cal. ad. large defect in vault. l. pterygo-spinous bridge |
| | — | — | — | — | — | — | — | — | cal. – f. ad. very defective base. faint post coronal |
| | — | — | — | — | — | — | — | — | dome. ad. [constriction |
| | — | — | — | — | — | — | — | — | cal. – f. ad. l. temporal defect. post coronal depression |
| 6 | — | — | — | — | — | — | — | — | cal. ad. l. facial defect. wormians partly united in |
| | — | — | — | — | — | — | — | — | dome. ad. [l. lambdoid suture |
| | — | — | — | — | — | — | — | — | dome. ad. |
| | — | — | — | — | — | — | — | — | cal. – f. ad. faint post coronal constriction. third occipital condyle somewhat to l. median ple. low elevation. 8 mm. trans. 5 mm. from t. to fore back. 5 mm. from anterior margin of foramen magnum, bearing articular facet |
| | — | — | — | — | — | — | — | — | dome. old |
| 2 | 76·5 | 105·5 | 69° | 72° | 39° | 10° | 29° | 82° | cal. ad. r. malar, l. zygomatic and small r. frontal defects. flattening of obelion |
| | — | — | — | — | — | — | — | — | cal. – f. ad. fronto-ethmoidal defect. very large inion. left *foramen ovale* subdivided |
| | — | — | — | — | — | — | — | — | cal. – f. ad. post coronal constriction. r. ossicle of pterion. bilateral pterygo-spinous bridge |
| 8 | — | 92·5 | 59°·5 | 78°·5 | 42° | — | — | — | cal. senile. l. zygomatic defect. r. pterygo-spinous bridge |
| | — | — | — | — | — | — | — | — | cal. – f. ad. large l. temporo-parietal defect |
| | — | — | — | — | — | — | — | — | cal. – f. ad. small r. occipital defect. bilateral ossicle |
| | — | — | — | — | — | — | — | — | dome. old? [of pterion |
| | 77·5 | 98 | 66° | 74° | 40° | — | — | — | cal. old. large defects |
| | 82·5 | 85 | 60°·5 | 72°·5 | 47° | 16°·5 | 30°·5 | 89° | cal. y. ad. with r. malar defect |
| | — | 79 | 57° | 83° | 40° | — | — | — | cal. ad. large l. temporo-parietal and r. facial defects. metopic; depression of obelion. r. ossicle of pterion |
| | — | — | — | — | — | — | — | — | cal. – f. old. |
| | — | — | — | — | — | — | — | — | cal. – f. ad. small r. occipital defect. faint post |
| | — | — | — | — | — | — | — | — | cal. – f. old? [coronal constriction |
| | — | — | — | — | — | — | — | — | cal. – f. ad. with r. sphenoidal defect |
| | — | — | — | — | — | — | — | — | dome. y. ad. metopic; post coronal depression. strongly developed inion |
| 9 | 72·3 | 102 | 69° | 66°·5 | 44°·5 | — | — | — | cal. ad. r. temporal and occipital defects |
| 4 | 76·1 | 87·5 | 59° | 78° | 43° | — | — | — | cal. ad. l. facial and temporal defects. ossicle of λ. 15 × 10 mm. |

| | | | Lengths | | | | | | | | Circumferences | | | Face | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Series No. | Sex | C | F | L′ | L | B | B′ | H | OH | LB | U | S | Q | G′H | GB | J | NH | NB | $O_1$ L | $O_1$ R | $O_2$ L | $O_2$ R |
| 189 | ♀ | — | 180 | 178 | 178 | 132 | 95 | 121 | 110 | 95 | 504 | 353 | 296 | 66·5 | 81? | — | 48 | 25 | — | 40·5 | 31·5 | 32 |
| 190 | ♀ | — | 186 | — | 185 | 138 | 94 | 132 | 113 *h* | 99 | 515 | 375 | *c.* | — | — | — | — | — | — | — | — | — |
| 191 | ♀ | — | 177 | — | 177 | 128 | 93 | 122 | 108 *h* | 91 | 493 | 363 | 290 | — | — | — | — | — | — | — | — | — |
| 192 | ♂ ?? | 1260 | 176 | — | 178 | 136 | 93 | 125 | 107 *h* | 97 | 493 | 354 | 291 | — | — | — | — | — | — | — | — | — |
| 193 | ♀ | 1375 | 174 | — | 174 | 141 | 91 | 120 | 110 *h* | 91 | 505 | 360 | 299 | — | — | — | — | — | — | — | — | — |
| 194 | ♀ | — | 183 | — | 182 | 132 | — | 125? | — | 95? | — | 370 | 294 | — | — | — | — | — | — | — | — | — |
| 195 | ♀ | — | 179 | — | 179 | 129 | 98 | — | 116 *h* | — | — | 370 | — | — | — | — | — | — | — | — | — | — |
| 196 | ♀ ? | — | 191 | — | 192 | 136 | 94 | — | 112 *h* | — | 522 | 376 | — | — | — | — | — | — | — | — | — | — |
| 197 | ♀ | — | — | — | — | — | — | — | 114 *h* | — | — | — | — | 67·5 | 86 | — | 51·5 | 26 | 41·5 | 42 | 33 | 34 |
| 198 | ♂ | — | 180 | — | 181 | — | 100 | 127 | 108 *h* | 107 | — | 352 | — | — | — | — | — | — | — | — | — | — |
| 199 | ♂ | — | 192 | — | 192 | 158 | 102 | — | 124 *h* | — | 553 | 389 | — | — | — | — | — | — | — | — | — | — |
| 200 | ♂ | 1440 | 189 | 192 | 193 | 135 | 97 | 137 | 116 | 105 | 520 | 380 | 305 | 72 | ? | 133 | 52 | 24·5 | 46·5 | 45·5 | 35·5 | 35·5 |
| 201 | ♀ | — | 180 | — | 181 | 133 | 89 | — | — | — | 499 | 357 | — | — | — | — | — | — | — | — | — | — |
| 202 | ♀ | — | 180 | — | 180 | 138 | 93 | — | — | — | 506 | — | — | — | — | — | — | — | — | — | — | — |
| 203 | ♀ | — | 181 | 179 | 180 | — | 99 | 128 | 112 | 92 | — | 367 | 293 | 64 | 86 | — | 48·5 | 24 | 42 | 42 | 35 | 35·5 |
| 204 | ♂ ? | — | 192 | — | 195 | 130 | 95 | 122 | — | 112 | 520 | 369 | — | — | — | — | — | — | — | — | — | — |
| 205 | ♂ ? | 1260 | 176 | 176 | 177 | 135 | 94 | 130 | 107 | 99 | 497 | 348 | 294 | 74 | 86 | 127 | 51 | 24·5 | 42 | 41·5 | 31·5 | 32 |
| 206 | ♀ | — | 192 | — | 193 | — | 87 | 128 | 114 *h* | 98 | 522 | 388 | — | 68 | — | — | 47·5 | 22·5 | — | 40 | — | 33 |
| 207 | ♀ | — | 179 | — | 181 | 123 | 91 | — | 107 *h* | — | 489 | 353 | — | 65 | 79 | 115 | 50 | 26 | 42 | 42 | 35·5 | 37·5 |
| 208 | ♀ | — | 173 | — | 173 | — | 94 | 127 | 110 *h* | 99 | 493 | 347 | 293 | — | — | 119 | — | — | — | — | — | — |
| 209 | ♀ | — | 181 | — | 181 | 136 | 92 | 123 | 114 *h* | 93 | 505 | 373 | — | 69·5 | 81 | — | 48·5 | 23 | 41·5 | 42 | 35·5 | 35·5 |
| 210 | ♂ | — | 183 | 185 | 185 | — | 96 | 126 | 108 | 96 | 520 | 368 | 297 | 65 | 92 | — | 50·5 | 24 | 44·5 | 42 | 34 | 32 |
| 211 | ♂ | — | 184 | 185 | 186 | 132 | 98 | 121 | 103 | 99 | 502 | 354 | 276 | 68 | 86 | 122 | 48 | 22·5 | 44 | 44 | 34·5 | 35 |
| 212 | ♂ | 1695 | 194 | 195 | 196 | 148 | 102 | 142 | 116 | 108 | 547 | 388 | 317 | 73 | 105 | 132 | 54 | 24 | 46 | 45 | 37 | 38 |
| 213 | ♂ | 1650 | 199 | — | 200 | 142 | 102 | 137 | 123 *h* | 100 | 545 | 407 | 323 | — | — | — | — | — | — | — | — | — |
| 214 | ♀ | — | 172 | — | 174 | 126 | 89 | 125 | 106 *h* | 95 | 481 | 344 | 272 | — | — | — | — | — | — | — | — | — |
| 215 | ♂ ?? | 1535 | 187 | 188 | 187 | 145 | 96 | 123 | 117 | 95 | 530 | 384 | 319 | 64 | 86 | 125 | 44·5 | 22 | 44 | 43·5 | 35 | 34 |
| 216 | ♀ | — | 180 | — | 182 | 142 | 91 | 121 | 108 *h* | 92 | 512 | 355 | 297 | — | — | — | — | — | — | — | — | — |
| 217 | ♂ | 1400 | 186 | — | 188 | 145 | 99 | 120 | 111 *h* | 99 | 525 | 378 | 306 | — | — | — | — | — | — | — | — | — |
| 218 | ♂ | — | 190 | 188 | 190 | 145 | 102 | 135 | 112 | 99 | 540 | 382 | 300 | 68 | 97 | 129 | 50·5 | 20·5 | 43 | 42·5 | 33 | 33·5 |
| 219 | ♀ ? | 1450 | 193 | 191 | 192 | 135 | 102 | 132 | 112·5 | 96 | 530 | 385 | 300 | 63 | — | — | 47·5 | 24 | 43 | — | 32·5 | — |
| 220 | ♀ | 1410 | 182 | 181 | 182 | 143 | 90 | 125 | 115 | 92 | 519 | 375 | 307 | 68 | 78 | 125 | 50·5 | 20 | 41·5 | 40·5 | 33 | 33 |
| 221 | ♂ | – | 189 | — | 192 | 138 | 94 | 128 | 114 *h* | 101 | 525 | 382 | 299 | — | — | — | — | — | — | — | — | — |

| | | $O_2$ | | Palate | | Indices | | | | | | | | | | Angles | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $L$ | $R$ | $G_1$ | $G_2$ | $B/L'$ | $H/L'$ | $B/L$ | $H/L$ | $B/H$ | $G'H/GB$ | $NB/NH$ | $O_2/O_1$ $L$ | $O_2/O_1$ $R$ | $G_2/G_1$ | $GL$ | $N\angle$ | $A\angle$ | $B\angle$ | $\theta_2$ | $\theta_1$ |
| 5 | 31·5 | 32 | 49 | 38 | 74·2 | 68 | 74·2 | 68 | 109 | 82·1 | 52·1 | — | 79 | 77·5 | 94 | 69° | 70° | 41° | 18° | 23° |
| | — | — | — | — | — | — | 74·6 | 71·3 | 104·6 | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | 72·3 | 68·9 | 104·9 | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | 76·4 | 70·2 | 108·8 | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | 81 | 69 | 117·5 | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | 72·5 | 68·7 | 105·6 | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | 72·1 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | 70·8 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | 33 | 34 | 46 | 39 | — | — | — | — | — | 78·5 | 50·5 | 79·5 | 80·9 | 84·8 | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 70·2 | — | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | 82·3 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 5 | 35·5 | 35·5 | 50 | 40 | 70·3 | 71·3 | 69·9 | 71 | 98·5 | — | 47·1 | 76·3 | 78 | 80 | 99·5 | 65° | 73°·5 | 41°·5 | 10°·5 | 31° |
| | — | — | — | — | — | — | 73·5 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | 76·7 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | 35 | 35·5 | 39 | 32 | — | 71·5 | — | 71·1 | — | 74·4 | 49·5 | 83·3 | 84·5 | 82 | 83·5 | 61°·5 | 76° | 42°·5 | 13° | 29°·5 |
| | — | — | — | — | — | — | 66·7 | 62·6 | 106·6 | — | — | — | — | — | — | — | — | — | — | — |
| 5 | 31·5 | 32 | — | 35 | 76·7 | 73·9 | 76·3 | 73·4 | 103·8 | 86 | 48 | 75 | 77·1 | — | 96 | 65°·5 | 70° | 44°·5 | 13° | 31°·5 |
| | — | 33 | 46 | 32? | — | — | — | 66·3 | — | — | 47·4 | — | 82·5 | 69·6 | 91 | 63° | 75° | 42° | — | — |
| | 35·5 | 37·5 | — | — | — | — | 68 | — | — | 82·3 | 52 | 84·5 | 89·3 | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | 73·4 | — | — | — | — | — | — | — | — | — | — | — | — |
| | 35·5 | 35·5 | 42 | 36 | — | — | 75·1 | 68 | 110·6 | 85·8 | 47·4 | 85·5 | 84·5 | 85·7 | 91 | 66°·5 | 70° | 43°·5 | — | — |
| | 34 | 32 | 47·5 | 36·5 | — | 68·1 | — | 68·1 | — | 70·6 | 47·5 | 76·4 | 76·2 | 76·8 | 96 | 70° | 70° | 40° | 12° | 28° |
| | 34·5 | 35 | 48 | 35 | 71·3 | 65·4 | 71 | 65 | 109 | 79·1 | 46·9 | 78·4 | 79·5 | 72·9 | 100 | 71° | 69° | 40° | 11° | 29° |
| | 37 | 38 | 48·5 | 34 | 75·9 | 72·8 | 75·5 | 72·4 | 104·3 | 69·5 | 44·4 | 80·4 | 84·4 | 70·1 | 97 | 61° | 77°·5 | 41°·5 | 6°·5 | 35° |
| | — | — | — | — | — | — | 71 | 68·5 | 103·6 | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | 72·4 | 71·8 | 100·8 | — | — | — | — | — | — | — | — | — | — | — |
| 5 | 35 | 34 | 48 | 34·5 | 77·1 | 65·4 | 77·5 | 65·8 | 117·9 | 74·4 | 49·4 | 79·5 | 78·2 | 71·9 | 92 | 67° | 73° | 40° | 17° | 23° |
| | — | — | — | — | — | — | 78 | 66·5 | 117·4 | — | — | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | 77·1 | 63·8 | 120·8 | — | — | — | — | — | — | — | — | — | — | — |
| 5 | 33 | 33·5 | 50 | 40·5 | 77·1 | 71·8 | 76·3 | 71 | 107·4 | 70·1 | 40·6 | 76·7 | 78·8 | 81 | 100 | 70°·5 | 69°·5 | 40° | 7°·5 | 32° 5 |
| | 32·5 | — | 47·5 | 32·5 | 70·7 | 69·1 | 70·3 | 68·7 | 102·2 | — | 50·5 | 75·6 | — | 68·4 | 88·5 | 64° | 77° | 39° | 10° | 29° |
| 5 | 33 | 33 | 43·5 | 32 | 79 | 69·1 | 78·6 | 68·7 | 114·4 | 87·2 | 39·6 | 79·5 | 81·5 | 73·6 | 84·5 | 61°·5 | 73°·5 | 45° | 20°·5 | 24°·5 |
| | — | — | — | — | — | — | 71·9 | 66·7 | 107·9 | — | — | — | — | — | — | — | — | — | — | — |

| ACE | | | | | PALATE | | INDICES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB | $O_1$ L | $O_1$ R | $O_2$ L | $O_2$ R | $G_1$ | $G_2$ | B/L′ | H/L′ | B/L | H/L | B/H | G′H/GB | NB/NH | $O_2/O_1$ L | $O_2/O_1$ R | $G_2/G_1$ | GL | N ∠ | A |
| 5 | — | 40·5 | 31·5 | 32 | 49 | 38 | 74·2 | 68 | 74·2 | 68 | 109 | 82·1 | 52·1 | — | 79 | 77·5 | 94 | 69° | 79 |
| — | — | — | — | — | — | — | — | — | 74·6 | 71·3 | 104·6 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 72·3 | 68·9 | 104·9 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 76·4 | 70·2 | 108·8 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 81 | 69 | 117·5 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 72·5 | 68·7 | 105·6 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 72·1 | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 70·8 | — | — | — | — | — | — | — | — | — | |
| 6 | 41·5 | 42 | 33 | 34 | 46 | 39 | — | — | — | — | — | 78·5 | 50·5 | 79·5 | 80·9 | 84·8 | — | — | |
| — | — | — | — | — | — | — | — | — | — | 70·2 | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 82·3 | — | — | — | — | — | — | — | — | — | |
| 4·5 | 46·5 | 45·5 | 35·5 | 35·5 | 50 | 40 | 70·3 | 71·3 | 69·9 | 71 | 98·5 | — | 47·1 | 76·3 | 78 | 80 | 99·5 | 65° | 7 |
| — | — | — | — | — | — | — | — | — | 73·5 | — | — | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 76·7 | — | — | — | — | — | — | — | — | — | |
| 4 | 42 | 42 | 35 | 35·5 | 39 | 32 | — | 71·5 | — | 71·1 | — | 74·4 | 49·5 | 83·3 | 84·5 | 82 | 83·5 | 61°·5 | 7 |
| — | — | — | — | — | — | — | — | — | 66·7 | 62·6 | 106·6 | — | — | — | — | — | — | — | |
| 4·5 | 42 | 41·5 | 31·5 | 32 | — | 35 | 76·7 | 73·9 | 76·3 | 73·4 | 103·8 | 86 | 48 | 75 | 77·1 | — | 96 | 65°·5 | 7 |
| 2·5 | — | 40 | — | 33 | 46 | 32? | — | — | — | 66·3 | — | — | 47·4 | — | 82·5 | 69·6 | 91 | 63° | 7 |
| 6 | 42 | 42 | 35·5 | 37·5 | — | — | — | — | 68 | — | — | 82·3 | 52 | 84·5 | 89·3 | — | — | — | |
| — | — | — | — | — | — | — | — | — | — | 73·4 | — | — | — | — | — | — | — | — | |
| 8 | 41·5 | 42 | 35·5 | 35·5 | 42 | 36 | — | — | 75·1 | 68 | 110·6 | 85·8 | 47·4 | 85·5 | 84·5 | 85·7 | 91 | 66°·5 | 7 |
| 4 | 44·5 | 42 | 34 | 32 | 47·5 | 36·5 | — | 68·1 | — | 68·1 | — | 70·6 | 47·5 | 76·4 | 76·2 | 76·8 | 96 | 70° | 7 |
| 2·5 | 44 | 44 | 34·5 | 35 | 48 | 35 | 71·3 | 65·4 | 71 | 65 | 109 | 79·1 | 46·9 | 78·4 | 79·5 | 72·9 | 100 | 71° | 6 |
| 8 | 46 | 45 | 37 | 38 | 48·5 | 34 | 75·9 | 72·8 | 75·5 | 72·4 | 104·3 | 69·5 | 44·4 | 80·4 | 84·4 | 70·1 | 97 | 61° | 7 |
| — | — | — | — | — | — | — | — | — | 71 | 68·5 | 103·6 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 72·4 | 71·8 | 100·8 | — | — | — | — | — | — | — | |
| — | 44 | 43·5 | 35 | 34 | 48 | 34·5 | 77·1 | 65·4 | 77·5 | 65·8 | 117·9 | 74·4 | 49·4 | 79·5 | 78·2 | 71·9 | 92 | 67° | 7 |
| — | — | — | — | — | — | — | — | — | 78 | 66·5 | 117·4 | — | — | — | — | — | — | — | |
| — | — | — | — | — | — | — | — | — | 77·1 | 63·8 | 120·8 | — | — | — | — | — | — | — | |
| 5 | 43 | 42·5 | 33 | 33·5 | 50 | 40·5 | 77·1 | 71·8 | 76·3 | 71 | 107·4 | 70·1 | 40·6 | 76·7 | 78·8 | 81 | 100 | 70°·5 | 6 |
| — | 43 | — | 32·5 | — | 47·5 | 32·5 | 70·7 | 69·1 | 70·3 | 68·7 | 102·2 | — | 50·5 | 75·6 | — | 68·4 | 88·5 | 64° | 7 |
| — | 41·5 | 40·5 | 33 | 33 | 43·5 | 32 | 79 | 69·1 | 78·6 | 68·7 | 114·4 | 87·2 | 39·6 | 79·5 | 81·5 | 73·6 | 84·5 | 61°·5 | 7 |
| — | — | — | — | — | — | — | — | — | 71·9 | 66·7 | 107·9 | — | — | — | — | — | — | — | |

# TABLE V.

| | Angles | | | | | | Remarks |
|---|---|---|---|---|---|---|---|
| *GL* | *N* ∠ | *A* ∠ | *B* ∠ | $\theta_2$ | $\theta_1$ | *P* ∠ | |
| 94 | 69° | 70° | 41° | 18° | 23° | 88° | cal. y. ad. l. malar and temporal defects. metopic; slight depression of obelion |
| — | — | — | — | — | — | — | cal. – f. old? sphenoidal and l. temporal defects |
| — | — | — | — | — | — | — | cal. – f. y. ad. spheno-ethmoidal and r. temporal defects. considerable l. precondylar eminence. faint post coronal depression |
| — | — | — | — | — | — | — | cal. – f. y. ad. marked post coronal constriction. very small r. jugular foramen. minute r. par-occipital process |
| — | — | — | — | — | — | — | cal. – f. ad. faint post coronal depression |
| — | — | — | — | — | — | — | dome. defective |
| — | — | — | — | — | — | — | cal. – f. ad. very imperfect |
| — | — | — | — | — | — | — | dome. ad. |
| — | — | — | — | — | — | — | upper and forepart skull. old? [pression |
| — | — | — | — | — | — | — | cal. – f. ad. very imperfect. metopic. coronal de- |
| — | — | — | — | — | — | — | dome. ad. very large. slight depression of obelion |
| 99·5 | 65° | 73°·5 | 41°·5 | 10°·5 | 31° | 84° | cal. old. heavy brow ridges |
| — | — | — | — | — | — | — | dome. old? faint depression of obelion |
| — | — | — | — | — | — | — | dome. ad. *torus occipitalis* |
| 83·5 | 61°·5 | 76° | 42°·5 | 13° | 29°·5 | 89° | cal. ad. large r. temporo-parietal defect [depression |
| — | — | — | — | — | — | — | dome. y. ad. sutures complicated. slight post coronal |
| 96 | 65°·5 | 70° | 44°·5 | 13° | 31°·5 | 83° | cal. y. ad. defect in r. superior maxilla. l. infra orbital suture on face |
| 91 | 63° | 75° | 42° | — | — | — | cal. ad. l. temporal, facial and r. zygomatic defects. *norma occipitalis* pentagonal |
| — | — | — | — | — | — | — | cal. old. occipital and r. temporal defects. slight post coronal constriction. nearly complete l. pterygo-spinous bridge |
| — | — | — | — | — | — | — | cal. – f. ad. r. temporal and l. sphenoid defects. slight post coronal depression. ossicle of λ, 13 × 10 mm. |
| 91 | 66°·5 | 70° | 43°·5 | — | — | — | cal. ad. large r. occipito-temporal defect. slight post coronal depression. bilateral precondylar eminences |
| 96 | 70° | 70° | 40° | 12° | 28° | 82° | cal. y. ad. r. parietal defect. faint post coronal |
| 100 | 71° | 69° | 40° | 11° | 29° | 80° | cal. ad. [constriction |
| 97 | 61° | 77°·5 | 41°·5 | 6°·5 | 35° | 84° | cal. ad. large r. ossicle of pterion, 41 × 12 mm. small r. fronto-sphenoidal ossicle? ossicles of lambdoid suture on both sides especially r. flattening and depression of obelion |
| — | — | — | — | — | — | — | cal. – f. ad. l. ossicle of pterion. bilateral precondylar eminences (double third condyle). faint post coronal depression |
| — | — | — | — | — | — | — | cal. – f. ad. r. fronto-sphenoidal defect. l. precondylar eminence. ossicles of Riolan [10 × 10 mm. |
| 92 | 67° | 73° | 40° | 17° | 23° | 90° | cal. ad. flattening of obelion. small ossicle of λ, |
| — | — | — | — | — | — | — | cal. – f. ad. frontal defect. division of l. parietal bone, posterior inferior part cut off by sinuous suture, leaving l. lambdoid at junction of inner $\frac{2}{3}$ths, with outer $\frac{1}{3}$ths, and joining middle of left squamous; detached portion 63 mm. from apex to base and 45 mm. across base, which abuts against temporal bone |
| — | — | — | — | — | — | — | cal. – f. ad. fractured l. parietal. faint post coronal depression. well marked interparietal |
| 100 | 70°·5 | 69°·5 | 40° | 7°·5 | 32° 5 | 77° | cal. y. ad. transverse fracture of base. slight post coronal depression. median element (*os pentagonale*) of interparietal fused with supra-occipital, lateral elements (*ossa triangularia*) distinct |
| 88·5 | 64° | 77° | 39° | 10° | 29° | 87° | cal. y. ad. r. malar defect. interparietal, median *os pentagonale* and r. *os triangulare* elements free. l. *os triangulare* fused. wormian in l. lambdoid. marked occipital projection |
| 84·5 | 61°·5 | 73°·5 | 45° | 20°·5 | 24°·5 | 94° | cal. ad. traces of *os pentagonale*, *ossa triangularia* fused with parietals? slight occipital prominence |
| — | — | — | — | — | — | — | cal. – f. ad. slight sagittal ridge. interparietal, median element (*os pentagonale*) free; l. *os triangulare* fused, r. very small, 20 × 25 mm. |

| | | | Lengths | | | | | | | | Circumferences | | | Face | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Series No. | Sex | *C* | *F* | *L'* | *L* | *B* | *B'* | *H* | *OH* | *LB* | *U* | *S* | *Q* | *G'H* | *GB* | *J* | *NH* | *NB* | $O_1 L$ | *R* | |
| 222 | ♂ | 1225 | 185 | — | 186 | 121 | 94 | 137 | 114 *h* | 109 | 493 | 370 | 290 | — | — | — | — | — | — | — | — |
| 223 | ♀ | 1330 | 178 | — | 181 | 147 | 100 | 121 | 112 *h* | 95 | 514 | 364 | 305 | — | — | — | — | — | — | — | — |
| 224 | ♀ | 1300 | 174 | — | 174 | 139 | 95 | — | 116 *h* | 90 | 498 | 359 | 320? | — | — | — | — | — | — | — | — |
| 225 | ♂? | — | 189 | — | 189 | 137 | 96 | 127 | — | 94 | 522 | 379 | — | — | — | — | — | — | — | — | — |
| 226 | ♀ | — | 181 | — | 181 | 134 | 91 | — | — | — | 502 | 367 | — | — | — | — | — | — | — | — | — |
| 227 | ♂? | 1485 | 186 | — | 188 | 137 | 96 | 129 | 112 | 101 | 517 | 383 | 297 | — | — | — | — | — | — | — | — |
| 228 | ♂ | — | 182 | — | 187 | 129 | 96 | 134 | 108 *h* | 106 | 505 | 365 | 281 | — | — | — | — | — | — | — | — |
| 229 | ♂? | — | 182 | 182 | 183 | 141 | 98 | 124 | 108 | 100 | 512 | 353 | 304 | 73·5 | 89 | 131 | 55 | 25 | 47 | 47·5 | 38 |
| 230 | ♂ | — | 187 | — | 189 | 143 | 103 | 141 | 115 *h* | 99 | 530 | 380 | — | — | — | — | — | — | — | — | — |
| 231 | ♀ | 1235 | 175 | — | — | 135 | 93 | 129 | 112 *h* | — | 495 | — | — | — | — | — | — | — | — | — | — |
| 232 | ♂ | — | 199 | — | 201 | 148 | 94 | — | — | — | 550 | 390 | — | — | — | — | — | — | — | — | — |
| 233 | ♀ | — | — | — | — | 132 | 94 | 116 | 103 *h* | 92 | — | — | 282 | — | — | — | — | — | — | — | — |
| 7037 | ♂ | — | 191 | 191 | 193 | 138 | 101 | 129 | 113 | 100 | 527 | 386 | 299 | 75 | 103 | 139 | 52·5 | 28 | 44 | 43 | 34 |
| 7038 | ♀ | 1540 | 188 | 186 | 186 | 142 | 97 | 133 | 116 | 98 | 527 | 385 | 312 | 67·5 | 96 | 127 | 50 | 22 | 42·5 | 42 | 32 |
| 7040 | ♀ | 1460 | 183 | 183 | 184 | 138 | 87 | 129 | 111 | 99 | 513 | 375 | 304 | 70 | 91 | — | 52·5 | 23·5 | 40 | 40 | 31 |
| 7041 | ♂ | — | 189 | 190 | 191 | 149 | 99 | 134 | 117 | 106 | 540 | 380 | 325 | 72 | 91? | — | 51·5 | 23 | 43·5 | — | 33 |
| 7042 | ♀? | 1575 | 188 | 189 | 189 | 144 | 91 | 133 | 122 | 93 | 523 | 400 | 329 | 67 | 87 | 124 | 49 | 24·5 | — | 41·5 | 33 |
| 7044 | ♀ | 1235 | 177 | 176 | 177 | 132 | 98 | 126 | 106 | 98 | 498 | 348 | 285 | 75 | 90 | 120 | 51·5 | 27 | 40·5 | 41·5 | 34 |
| 7045 | ♂ | 1570 | 190 | 192 | 193 | 146 | 99 | 132 | 120 | 108 | 536 | 382 | 321 | 73 | 95 | — | 52 | 21 | 44·5 | 44 | 34 |
| 7046 | ♀ | 1200 | 178 | — | 178 | 138 | 94 | 120 | 107 *h* | 91 | 503 | 359 | 288 | — | — | — | — | — | — | — | — |
| 7047 | ♀ | 1230 | 178 | 178 | 178 | 134 | 93 | 124 | 107 | 97 | 500 | 355 | 288 | 70 | 83 | 117 | 50·5 | 26 | 42 | 44 | 35 |
| 7048 | ♂? | 1375 | 186 | 188 | 188 | 140 | 96 | 124 | 110 | 99 | 518 | 368 | 302 | 67·5 | 89 | 128 | 51·5 | 23 | 43·5 | 43 | 31 |
| 7049 | ♂ | 1490 | 192 | 197 | 197 | 141 | 96 | 133 | 116 | 104 | 532 | 393 | 307 | 75 | — | — | 54·5 | 23 | 43 | — | 34 |
| 7050 | ♀ | 1305 | 181 | 180 | 181 | 137 | 84 | 128 | 112 | 93 | 503 | 367 | 310 | 72 | 81 | — | 52 | 22·5 | 40 | 39·5 | 34 |
| 7051 | ♀ | 1455 | 193 | — | — | 137 | 99 | 125 | 113 *h* | — | 528 | — | 301 | — | — | — | — | — | — | — | — |
| 7052 | ♂ | — | 193 | 191 | 193 | 142 | — | 132 | 115 | 98 | — | 394 | 309 | 72 | — | — | 52 | 22 | — | 41 | 34 |
| 7053 | ♀ | 1500 | 192 | 190 | 191 | 135 | 95 | 127 | 115 | 96 | 527 | 393 | 306 | 66 | 85 | 115 | 45 | 26 | 42 | 40·5 | 3 |
| 7054 | ♀ | 1500 | 194? | — | 193 | 137 | 97 | 132 | 114 *h* | 93? | 533 | 392? | 299 | — | — | — | — | — | — | — | |
| 7055 | ♂ | 1410 | 181 | 180 | 182 | 144 | 107 | 132 | 116 | 96 | 522 | 372 | 317 | 68 | 93 | — | 48 | 24 | 43 | 41·5 | 3 |
| 7056 | ♂ | 1545 | 190 | 192 | 192 | 137 | 99 | 138 | 116 | 103 | 521 | 380 | 301 | 66 | 89 | 135 | 51 | 25 | 44 | 43 | 3 |

7039 not seen.

| | $O_1$ | | $O_2$ | | Palate | | Indices | | | | | | | | | | Angl | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *L* | *R* | *L* | *R* | $G_1$ | $G_2$ | *B/L'* | *H/L'* | *B/L* | *H/L* | *B/H* | *G'H/GB* | *NB/NH* | $O_2/O_1$ *L* | $O_2/O_1$ *R* | $G_2/G_1$ | *GL* | *N* ∠ | *A* ∠ | *B* ∠ |
| — | — | — | — | — | — | — | — | 65 | 73·7 | 88·3 | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | 81·2 | 66·8 | 121·5 | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | 79·9 | — | — | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | 72·5 | 67·2 | 107·9 | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | 74 | — | — | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | 72·9 | 68·6 | 106·1 | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | 69 | 71·7 | 96·2 | — | — | — | — | — | — | — | — | — |
| 47 | 47·5 | 38 | 39 | 45·5 | 38 | 77·5 | 68·1 | 77 | 67·8 | 113·8 | 82·6 | 45·4 | 80·8 | 82·1 | 83·5 | 90 | 60° | 74°·5 | 45°·5 |
| — | — | — | — | — | — | — | — | 75·7 | 74·6 | 101·4 | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | — | 104·6 | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | 73·6 | — | — | — | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | — | 113·8 | — | — | — | — | — | — | — | — | — |
| 44 | 43 | 34·5 | 32·5 | 49 | 43 | 72·2 | 67·5 | 71·5 | 66·8 | 106·9 | 72·8 | 53·3 | 78·4 | 75·6 | 87·8 | 93·5 | 62°·5 | 72° | 45°·5 |
| 42·5 | 42 | 32·5 | 32·5 | 45 | 40 | 76·3 | 71·5 | 76·3 | 71·5 | 106·7 | 70·3 | 44 | 76·5 | 77·4 | 88·9 | 91·5 | 64° | 74° | 42° |
| 40 | 40 | 31·5 | 33·5 | 47·5 | 34·5 | 75·4 | 70·5 | 75 | 70·1 | 106·9 | 76·9 | 44·8 | 78·7 | 83·7 | 72·6 | 96 | 66°·5 | 71°·5 | 42° |
| 43·5 | — | 33 | — | 48 | 37 | 78·4 | 70·5 | 78 | 70·2 | 111·2 | 79·1 | 44·7 | 75·9 | — | 77·1 | 104·5 | 69° | 71° | 40° |
| — | 41·5 | 33 | 32·5 | 44·5 | 39 | 76·2 | 70·4 | 76·2 | 70·4 | 108·2 | 77 | 50 | — | 78·3 | 87·6 | 85 | 61°·5 | 74°·5 | 44° |
| 40·5 | 41·5 | 34 | 33·5 | 48·5 | 34·5 | 75 | 71·6 | 74·6 | 71·2 | 104·8 | 83·3 | 52·4 | 83·9 | 80·7 | 71·1 | 94 | 64° | 70° | 46° |
| 44·5 | 44 | 34·5 | 34 | 48 | 37 | 76 | 68·7 | 75·6 | 68·4 | 110·6 | 76·8 | 40·4 | 77·5 | 77·3 | 77·1 | 97·5 | 61°·5 | 77° | 41°·5 |
| — | — | — | — | — | — | — | — | 77·5 | 67·4 | 114·9 | — | — | — | — | — | — | — | — | — |
| 42 | 44 | 35·5 | 36·5 | 48·5 | 33·5 | 75·3 | 69·7 | 75·3 | 69·7 | 108·1 | 84·3 | 51·5 | 84·5 | 82·9 | 69·1 | 94·5 | 66°·5 | 70°·5 | 43° |
| 43·5 | 43 | 31·5 | 30·5 | 47·5 | 37 | 74·5 | 66 | 74·5 | 66 | 112·9 | 75·8 | 44·7 | 72·4 | 70·9 | 77·9 | 96 | 67°·5 | 72° | 40°·5 |
| 43 | — | 34 | — | 47·5 | 41 | 71·6 | 67·5 | 71·6 | 67·5 | 106 | — | 42·2 | 79·1 | — | 86·3 | 93 | 60° | 76° | 44° |
| 40 | 39·5 | 34·5 | 33 | 45 | 34·5? | 76·1 | 71·1 | 75·7 | 70·7 | 107·1 | 88·9 | 43·3 | 86·2 | 83·5 | 76·7 | 87·5 | 63° | 70°·5 | 46°·5 |
| — | — | — | — | — | — | — | — | — | — | 109·6 | — | — | — | — | — | — | — | — | — |
| — | 41 | 34 | 34 | 49 | 40 | 74·3 | 69·1 | 73·6 | 68·4 | 107·5 | — | 42·3 | — | 82·9 | 81·6 | 98 | 68°·5 | 68°·5 | 43° |
| 42 | 40·5 | 31 | 30 | — | 36 | 71 | 66·8 | 70·7 | 66·5 | 106·3 | 77·6 | 57·8 | 73·8 | 74·1 | — | 94 | 68° | 71° | 41° |
| — | — | — | — | — | — | — | — | 71 | 68·4 | 103·8 | — | — | — | — | — | — | — | — | — |
| 43 | 41·5 | 31 | 33 | 47·5 | 40·5 | 80 | 73·3 | 79·1 | 72·5 | 109 | 73·1 | 50 | 72·1 | 79·5 | 85·3 | 91 | 65° | 73° | 42° |
| 44 | 43 | 31 | 31 | 48·5 | 36·5 | 71·3 | 71·9 | 71·3 | 71·9 | 99·3 | 74·2 | 49 | 70·4 | 72·1 | 75·3 | 96·5 | 65°·5 | 76° | 38°·5 |

**7043** a Negro skull.

| | | | | | Palate | | Indices | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $O_1$ | | $O_2$ | | | | | | | | | | | | | | | |
| B | L | R | L | R | $G_1$ | $G_2$ | B/L′ | H/L′ | B/L | H/L | B/H | G′H/GB | NB/NH | $O_2/O_1$ L | $O_2/O_1$ R | $G_2/G_1$ | GL | N ∠ |
| | — | — | — | — | — | — | — | — | 65 | 73·7 | 88·3 | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 81·2 | 66·8 | 121·5 | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 79·9 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 72·5 | 67·2 | 107·9 | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 74 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 72·9 | 68·6 | 106·1 | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 69 | 71·7 | 96·2 | — | — | — | — | — | — | — |
| | 47 | 47·5 | 38 | 39 | 45·5 | 38 | 77·5 | 68·1 | 77 | 67·8 | 113·8 | 82·6 | 45·4 | 80·8 | 82·1 | 83·5 | 90 | 60° |
| | — | — | — | — | — | — | — | — | 75·7 | 74·6 | 101·4 | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | — | — | 104·6 | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | 73·6 | — | — | — | — | — | — | — | — | — |
| | — | — | — | — | — | — | — | — | — | — | 113·8 | — | — | — | — | — | — | — |
| | 44 | 43 | 34·5 | 32·5 | 49 | 43 | 72·2 | 67·5 | 71·5 | 66·8 | 106·9 | 72·8 | 53·3 | 78·4 | 75·6 | 87·8 | 93·5 | 62°·5 |
| | 42·5 | 42 | 32·5 | 32·5 | 45 | 40 | 76·3 | 71·5 | 76·3 | 71·5 | 106·7 | 70·3 | 44 | 76·5 | 77·4 | 88·9 | 91·5 | 64° |
| 5 | 40 | 40 | 31·5 | 33·5 | 47·5 | 34·5 | 75·4 | 70·5 | 75 | 70·1 | 106·9 | 76·9 | 44·8 | 78·7 | 83·7 | 72·6 | 96 | 66°·5 |
| | 43·5 | — | 33 | — | 48 | 37 | 78·4 | 70·5 | 78 | 70·2 | 111·2 | 79·1 | 44·7 | 75·9 | — | 77·1 | 104·5 | 69° |
| 5 | — | 41·5 | 33 | 32·5 | 44·5 | 39 | 76·2 | 70·4 | 76·2 | 70·4 | 108·2 | 77 | 50 | — | 78·3 | 87·6 | 85 | 61°·5 |
| | 40·5 | 41·5 | 34 | 33·5 | 48·5 | 34·5 | 75 | 71·6 | 74·6 | 71·2 | 104·8 | 83·3 | 52·4 | 83·9 | 80·7 | 71·1 | 94 | 64° |
| | 44·5 | 44 | 34·5 | 34 | 48 | 37 | 76 | 68·7 | 75·6 | 68·4 | 110·6 | 76·8 | 40·4 | 77·5 | 77·3 | 77·1 | 97·5 | 61°·5 |
| | — | — | — | — | — | — | — | — | 77·5 | 67·4 | 114·9 | — | — | — | — | — | — | — |
| | 42 | 44 | 35·5 | 36·5 | 48·5 | 33·5 | 75·3 | 69·7 | 75·3 | 69·7 | 108·1 | 84·3 | 51·5 | 84·5 | 82·9 | 69·1 | 94·5 | 66°·5 |
| | 43·5 | 43 | 31·5 | 30·5 | 47·5 | 37 | 74·5 | 66 | 74·5 | 66 | 112·9 | 75·8 | 44·7 | 72·4 | 70·9 | 77·9 | 96 | 67°·5 |
| | 43 | — | 34 | — | 47·5 | 41 | 71·6 | 67·5 | 71·6 | 67·5 | 106 | — | 42·2 | 79·1 | — | 86·3 | 93 | 60° |
| | 40 | 39·5 | 34·5 | 33 | 45 | 34·5? | 76·1 | 71·1 | 75·7 | 70·7 | 107·1 | 88·9 | 43·3 | 86·2 | 83·5 | 76·7 | 87·5 | 63° |
| | — | — | — | — | — | — | — | — | — | — | 109·6 | — | — | — | — | — | — | — |
| | — | 41 | 34 | 34 | 49 | 40 | 74·3 | 69·1 | 73·6 | 68·4 | 107·5 | — | 42·3 | — | 82·9 | 81·6 | 98 | 68°·5 |
| | 42 | 40·5 | 31 | 30 | — | 36 | 71 | 66·8 | 70·7 | 66·5 | 106·3 | 77·6 | 57·8 | 73·8 | 74·1 | — | 94 | 68° |
| | — | — | — | — | — | — | — | — | 71 | 68·4 | 103·8 | — | — | — | — | — | — | — |
| | 43 | 41·5 | 31 | 33 | 47·5 | 40·5 | 80 | 73·3 | 79·1 | 72·5 | 109 | 73·1 | 50 | 72·1 | 79·5 | 85·3 | 91 | 65° |
| | 44 | 43 | 31 | 31 | 48·5 | 36·5 | 71·3 | 71·9 | 71·3 | 71·9 | 99·3 | 74·2 | 49 | 70·4 | 72·1 | 75·3 | 96·5 | 65°·5 |

**7043** a Negro skull.

# TABLE VI.

| | | Angles | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | *GL* | *N* ∠ | *A* ∠ | *B* ∠ | $\theta_2$ | $\theta_1$ | *P* ∠ | |
| | — | — | — | — | — | — | — | cal. – f. ad. heavy brow ridges. interparietal, *os pentagonale* distinct, *ossa triangularia* fused. slight precondylar eminences |
| | — | — | — | — | — | — | — | cal. – f. ad. ethmoidal defect. platybaric. considerable ossicle of λ, 26 × 20 mm. faint post coronal depression |
| | — | — | — | — | — | — | — | cal. – f. ad. ossicle of λ, 33 × 28 mm. and other ossicles in lambdoid suture |
| | — | — | — | — | — | — | — | cal. – f. ad. very defective base. ossicle of λ, 17 × 15 mm. faint post coronal depression |
| | — | — | — | — | — | — | — | dome. ad. marked post coronal constriction. paired ossicles of λ, each about 20 × 15 mm. some occipital prominence. wormians, chiefly in r. lambdoid suture |
| | — | — | — | — | — | — | — | cal. – f. ad. traces of ossicle of bregma, 20 × 13 mm. |
| | — | — | — | — | — | — | — | cal. – f. ad. very defective base. ossicle of bregma, 20 × 20 mm. r. parietal flattening |
| 5 | 90 | 60° | 74°·5 | 45°·5 | 15°·5 | 30° | 90° | cal. ad. l. and r. parietal defects. *hamulus lacrymalis* reaches face |
| | — | — | — | — | — | — | — | cal. – f. ad. with basal and left temporal defects. plagiocephalic, wormian, 15 × 15 mm. in l. coronal suture [depression of obelion |
| | — | — | — | — | — | — | — | cal. – f. y. ad. marked plagiocephaly; r. side smaller. |
| | — | — | — | — | — | — | — | dome. ad. plagiocephalic, r. occipital and l. frontal flattening. r. post coronal depression |
| | — | — | — | — | — | — | — | cal. – f. ad. large occipital defect. slight post coronal depression. interparietal, *os pentagonale* and l. *os triangulare* distinct, r. *os triangulare* missing |
| 8 | 93·5 | 62°·5 | 72° | 45°·5 | 16° | 29°·5 | 88° | cal. ad. robust and powerful |
| 9 | 91·5 | 64° | 74° | 42° | 14° | 28° | 88° | cal. ad. (? y.) metopic. forehead peculiarly infantile in character, slight bathrocephaly. ossicle of λ, 17 × 20 mm. and other ossicles in lambdoid suture, slight coronal depression |
| 6 | 96 | 66°·5 | 71°·5 | 42° | 12°·5 | 29°·5 | 84° | cal. ad. zygomatic arches defective |
| 1 | 104·5 | 69° | 71° | 40° | 12° | 28° | 83° | cal. y. ad. r. zygomatic arch and outer wall of orbit defective. upper r. canine coming through behind lateral incisor |
| 6 | 85 | 61°·5 | 74°·5 | 44° | 19°·5 | 24°·5 | 94° | cal. ad. l. orbit imperfect. very pronounced bathrocephaly. large ossicles in lambdoid suture. lozenge shaped ossicle of bregma, 60 × 50 mm. |
| 1 | 94 | 64° | 70° | 46° | 13° | 33° | 83° | cal. ad. slight groove of obelion [wards 6 mm. |
| 1 | 97·5 | 61°·5 | 77° | 41°·5 | 17° | 24°·5 | 94° | cal. ad. l. zygoma defective, inion projects down- |
| | — | — | — | — | — | — | — | cal. – f. ad. slight defect occipital bone |
| 1 | 94·5 | 66°·5 | 70°·5 | 43° | 12°·5 | 30°·5 | 83° | cal. ad. r. zygoma defective |
| 9 | 96 | 67°·5 | 72° | 40°·5 | 16° | 24°·5 | 88°? | cal. ad. |
| 3 | 93 | 60° | 76° | 44° | 16° | 28° | 92° | cal. old? zygomatic arch, outer wall of orbit and maxilla defective on r. side, heavy powerfully built skull with strong brow ridges and inion |
| 7 | 87·5 | 63° | 70°·5 | 46°·5 | 17°·5 | 29° | 88° | cal. ad. (? y.) left zygoma defective. infantile type. small ossicles in lambdoid suture. slight flattening of obelion |
| | — | — | — | — | — | — | — | cal. – f. old. small defects in both temporal regions. exostosis pedunculated 30 mm. long × 18 mm. broad in l. occipital region |
| 6 | 98 | 68°·5 | 68°·5 | 43° | 14°·5 | 28°·5 | 83° | cal. ad. l. malar region defective. large defect in r. frontal. small defect in region of obelion, probably due to injury ante mortem. *os interparietale*, *os pentagonale* and l. *os triangulare* distinct. r. *os triangulare* apparently absent; place supplied by growth of parietal pentagonal and especially supra-occipital |
| | 94 | 68° | 71° | 41° | 18° | 23° | 89° | cal. y. ad. |
| | — | — | — | — | — | — | — | cal. – f. ad. ethmoidal defect |
| 3 | 91 | 65° | 73° | 42° | 15° | 27° | 88° | cal. ad. both zygomata defective [lambdoid suture |
| 3 | 96·5 | 65°·5 | 76° | 38°·5 | 8° | 30°·5 | 84° | cal. old. trace of bathrocephaly. small ossicles in |

| | | | Lengths | | | | | | | | Circumferences | | | Face | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Series No. | Sex | C | F | L' | L | B | B' | H | OH | LB | U | S | Q | G'H | GB | J | NH | NB | $O_1$ L | $O_1$ R | $O_2$ L | $O_2$ |
| 7057 | ♀ | 1155 | 179 | 181 | 180 | 128 | 93 | 122 | 105 | 100 | 493 | 352 | 278 | 57 | 85 | 119 | 47·5 | 25 | 39·5 | 40 | 33 | 33 |
| 7058 | ♂ | 1660 | 191 | 189 | 189 | 153 | 109 | 136 | 115 | 100 | 553 | 385 | 316 | 71 | — | — | 49 | 26·5 | — | 43·5 | — | 32 |
| 7059 | ♀ | 1425 | 196 | 196 | 196 | 138 | 99 | 128 | 112 | 98 | 540 | 389 | 299 | 74 | — | — | 56·5 | 25 | — | 43 | 35 | 36 |
| 7060 | ♀? | 1355 | 179 | 180 | 181 | 137 | 101 | 132 | 114 | 99 | 505 | 366 | 304 | 62·5 | 89 | 133 | 49·5 | 24 | 41 | 41 | 34 | 34 |
| 7061 | ♀ | 1330 | 182 | 183 | 182 | 134 | 96 | 121 | 111 | 95 | 515 | 362 | 300 | 61? | — | — | 49 | 24 | 39·5 | — | 36·5 | |
| 7089 | ♂ | 1580 | 184 | 187 | 187 | 148 | 92 | 133 | 118 | 102 | 528 | 377 | 320 | 76 | — | — | 54 | 23·5 | 44 | — | 34 | |
| 7090 | ♀? | 1390? | 182 | 185 | 185 | 140 | 98 | 118 | 108 | 98 | 512 | 358 | 307 | 66 | — | — | 51 | 23·5 | 45 | 45·5 | 34 | 33 |
| 7091 | ♀ | 1190 | 180 | 179 | 181 | 130 | 89 | 121 | 105 | 94 | 495 | 352 | 285 | 66 | 83 | — | 49 | 22·5 | 43 | 42·5 | 36 | 35 |
| 7092 | ♀ | 1225 | 187 | 189 | 188 | 130 | 90 | 121 | 103 | 93 | 507 | 375 | 275 | 66 | 88 | — | 48·5 | 21 | 40·5 | 42 | 32 | 33 |
| 7093 | ♀ | 1350 | 183 | 181 | 182 | 140 | 91 | 125 | 112 | 94 | 507 | 376 | 302 | 68·5? | 84 | 115 | 48 | 23 | 42·5 | 41·5 | 34 | 34 |
| 7094 | ♂ | 1605 | 186 | 184 | 185 | 144 | 103 | 132 | 117 | 99 | 529 | 382 | 317 | 77·5 | — | 138 | 53·5 | 22 | — | 44 | — | 35 |
| 7095 | ♂ | 1430 | 187 | 188 | 189 | 138 | 96 | 133 | 111 | 103 | 521 | 377 | 301 | 72 | 90 | 135 | 52 | 23·5 | 41 | 40·5 | 32 | 32 |
| 7096 | ♀ | 1205 | 180 | 179 | 181 | 138 | 91 | 119 | 106 | 95 | 512 | 363 | 292 | 74 | 91 | — | 54 | 22 | 41·5 | 40·5 | 33·5 | 34 |
| 7097 | ♀ | 1205 | 170 | 170 | 171 | 136 | 91 | 127 | 110 | 92 | 487 | 353 | 291 | 67 | 82 | 112 | 47 | 22 | 40 | 39 | 32 | 30 |
| 7098 | ♀ | 1345 | 186 | 184 | 186 | 130 | 93 | 127 | 108 | 98 | 508 | 366 | 287 | 60 | 85 | 122 | 45 | 24 | 41·5 | 43 | 32 | 33 |
| 7099 | ♀ | 1630 | 191 | 190 | 190 | 141 | 92 | 136 | 121 | 99 | 529 | 398 | 319 | 60·5 | 71 | — | 45 | 22 | 42 | 41 | 33·5 | 35 |
| 7100 | ♀ | 1395 | 183 | 183 | 183 | 136 | 97 | 119 | 109 | 96 | 511 | 356 | 291 | 64 | 86 | — | 48 | 23·5 | 42 | 42·5 | 33 | 33 |
| 7101 | ♂ | — | 186 | 190 | 189 | 150 | 101 | 137 | 120 | 102 | 540 | 387 | 326 | 70·5 | 93 | 135 | 53 | 22·5 | 44 | 43·5 | 33·5 | 34 |
| 7102 | ♂ | — | 189 | 191 | 192 | 148 | 100 | 134 | 114 | 105 | 534 | 380 | 311 | — | 85 | 129 | 50 | — | — | 39·5 | 31? | 30 |
| 7103 | ♀ | — | 184 | — | 185 | 139 | 91 | 131 | 111 *h* | 96 | 521 | 385 | 298 | — | — | — | — | — | — | — | — | |
| 7104 | ♀ | 1450 | 191 | 191 | 191 | 133 | 92 | 130 | 111 | 101 | 518 | 385 | 293 | 75 | 93 | 121 | 53·5 | 24 | 41 | 40·5 | 32 | 32 |
| 7105 | ♂? | 1445 | 186 | 186 | 187 | 137 | 102 | 123 | 108 | 102 | 522 | 366 | 292 | 72·5 | 86 | 130 | 56·5 | 19·5 | 45·5 | 47 | 39 | 40 |
| 7106 | ♀ | — | 180 | 180 | 180 | 134 | 88 | 119 | 107 | 94 | — | 367 | — | 57 | 82 | — | 48 | 23 | 40? | 40? | 34? | 32 |
| 7107 | ♂ | 1530 | 182 | 184 | 184 | 138 | 101 | 136 | 120 | 106 | 515 | 369 | 311 | 67 | 94 | 134 | 51 | 27 | 45 | 45 | 32·5 | 32 |
| 7108 | ♀ | 1200 | 181 | 179 | 181 | 133 | 92 | 123 | 107 | 97 | 502 | 351 | 287 | 61 | 88 | — | 44·5 | 24 | 41 | 42 | 32·5 | 32 |
| 7109 | ♂ | — | 192 | — | 196 | 145 | 103 | 132 | 113 *h* | 106 | 538 | 380 | — | — | — | — | — | — | — | — | — | |
| 7110 | ♀ | — | 177 | 178 | 179 | 132 | 95 | 134 | 114 | 101 | 503 | 368 | 308 | 68 | 88 | 121 | 51 | 21·5 | 43 | 42 | 33 | 33 |
| 7111 | ♂ | 1650 | 192 | 192 | 192 | 145 | 97 | 142 | 122 | 102 | 536 | 389 | 321 | 59·5 | 94 | 132 | 45·5 | 23·5 | 42 | 42·5 | 30·5 | 33 |
| 7112 | ♂ | 1490 | 186 | 186 | 185 | 142 | 96 | 126 | 111 | 99 | 531 | 374 | 304 | 68 | 96 | 130 | 49 | 23 | 45 | 46 | 30·5 | 33 |
| 7113 | ♀ | — | 184 | 182 | 183 | 134 | 92 | — | 107 | — | 514 | 372 | 292 | 65 | 82? | — | 48·5 | 25 | — | 40·5 | 34 | 33 |
| 7114 | ♀ | 1385 | 184 | 182 | 184 | 142 | 99 | 126 | 109 | 100 | 525 | 370 | 305 | 69 | 89 | 126 | 53 | 22 | 40·5 | 40 | 34·5 | 33 |
| 7115 | ♀ | 1045 | 164 | 162 | 163 | 126 | 90 | 116 | 99 | 88 | 465 | 334 | 260 | 55·5 | 86 | 116 | 42 | 20·5 | 38 | 37·5 | 31 | 33 |
| 7116 | ♂?? | — | 169 | 171 | 171 | 136 | 94 | 127 | 110 | 98 | 489 | 350 | 290 | 66 | 86 | — | 46 | 24 | 39·5 | 40 | 31·5 | 33 |
| 7117 | ♂ | 1630 | 201 | 203 | 203 | 143 | 97 | 133 | 120 | 100 | 556 | 407 | 320 | 76·5 | 92 | — | 57·5 | 28 | 43 | 44 | 36·5 | 33 |
| 7118 | ♂ | — | 180? | 185? | 184? | 143 | 97 | 132 | 113 | 104 | 515? | 363? | 302 | 59 | 99? | 138 | 46·5 | 27 | 43·5 | 43 | 34 | 33 |
| 7119 | ♂ | 1870 | 196 | 197 | 196 | 148 | 105 | 137 | 123 | 98 | 558 | 410 | 342 | 73·5 | 91 | 131 | 51·5 | 25 | 44 | 43·5 | 38 | 33 |
| 7120 | ♀ | 1345 | 188 | 190 | 191 | 135 | 96 | 126 | 103 | 99 | 515 | 376 | 275 | 62 | 95 | — | 45·5 | 22·5 | 42·5 | 43 | 34·5 | 33 |

| | | | Palate | | Indices | | | | | | | | | | | Angl | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $O_1$ R | $O_2$ L | $O_2$ R | $G_1$ | $G_2$ | B/L′ | H/L′ | B/L | H/L | B/H | G′H/GB | NB/NH | $O_2/O_1$ L | $O_2/O_1$ R | $G_2/G_1$ | GL | N ∠ | A ∠ | B ∠ |
| 40 | 33 | 33 | — | 40 | 70·7 | 67·4 | 71·1 | 67·8 | 104·9 | 67·1 | 52·6 | 83·5 | 82·5 | — | 94 | 67° | 79° | 34° |
| 43·5 | — | 32·5 | — | 38·5 | 80·9 | 72 | 80·9 | 72 | 112·5 | — | 54·1 | — | 74·7 | — | 96 | 65°·5 | 72° | 42°·5 |
| 43 | 35 | 36·5 | 49·5 | 35·5 | 70·4 | 65·3 | 70·4 | 65·3 | 107·9 | — | 44·2 | — | 84·9 | 71·7 | 92 | 63° | 71° | 46° |
| 41 | 34 | 34 | 46 | 38·5 | 76·1 | 73·3 | 75·7 | 72·9 | 103·8 | 70·2 | 48·5 | 82·9 | 82·9 | 83·7 | 90·5 | 63°·5 | 78°·5 | 38° |
| — | 36·5 | — | 42·5 | 36·5 | 73·2 | 66·1 | 73·6 | 66·5 | 110·7 | — | 49 | 92·4 | — | 85·9 | 89·5 | 66° | 76° | 38° |
| — | 34 | — | 50 | 31·5 | 79·1 | 71·1 | 79·1 | 71·1 | 111·2 | — | 43·5 | 77·3 | — | 63 | 90 | 58°·5 | 75°·5 | 46° |
| 45·5 | 34 | 33 | 44·5 | 36·5 | 75·7 | 63·8 | 75·7 | 63·8 | 118·6 | — | 46·1 | 75·6 | 72·5 | 82 | 91·5 | 64°·5 | 75° | 40°·5 |
| 42·5 | 36 | 35 | — | 31·5 | 72·6 | 67·6 | 71·8 | 66·8 | 107·4 | 79·5 | 45·9 | 83·7 | 82·3 | — | 87 | 63° | 74° | 43° |
| 42 | 32 | 33 | 45 | 38·5 | 68·8 | 64 | 69·1 | 64·4 | 107·4 | 75 | 43·3 | 79 | 78·6 | 85·6 | 93 | 69° | 69° | 42° |
| 41·5 | 34 | 34·5 | 43 | 35 | 77·3 | 69·1 | 76·9 | 68·7 | 112 | 81·5 | 47·9 | 80 | 83·1 | 81·4 | 85·5 | 61° | 74° | 45° |
| 44 | — | 35 | 48·5 | — | 78·3 | 71·7 | 77·8 | 71·3 | 109 | — | 41·1 | — | 79·5 | — | 93·5 | 63° | 70° | 47° |
| 40·5 | 32 | 32·5 | 46·5 | 37 | 73·4 | 70·7 | 73 | 70·4 | 103·7 | 80 | 45·2 | 78 | 80·2 | 79·6 | 97 | 64°·5 | 73°·5 | 42° |
| 40·5 | 33·5 | 34 | 47 | 42·5 | 77·1 | 66·5 | 76·2 | 65·7 | 116 | 81·3 | 40·7 | 80·7 | 83·9 | 90·4 | 96 | 68° | 66°·5 | 45°·5 |
| 39 | 32 | 30·5 | 45·5 | — | 80 | 74·7 | 79·5 | 74·3 | 107·1 | 81·7 | 46·8 | 80 | 78·2 | — | 89·5 | 66° | 70°·5 | 43°·5 |
| 43 | 32 | 33 | 48·5 | 36 | 70·6 | 69 | 69·9 | 68·3 | 102·3 | 70·6 | 53·3 | 77·1 | 76·7 | 74·2 | 95 | 69° | 74°·5 | 36°·5 |
| 41 | 33·5 | 35 | 42·5 | 30 | 74·2 | 71·6 | 74·2 | 71·6 | 103·7 | 85·2 | 48·9 | 79·8 | 85·4 | 70·6 | 89·5 | 63° | 80° | 37° |
| 42·5 | 33 | 33·5 | — | — | 74·3 | 65 | 74·3 | 65 | 114·3 | 74·4 | 49 | 78·6 | 78·8 | — | 92 | 67° | 73°·5 | 39°·5 |
| 43·5 | 33·5 | 34 | 49·5 | 34·5 | 78·9 | 72·1 | 79·4 | 72·5 | 109·5 | 75·8 | 42·4 | 76·1 | 78·2 | 69·7 | 102 | 70° | 70° | 40° |
| 39·5 | 31? | 30 | 48 | 38? | 77·5 | 70·2 | 77·1 | 69·8 | 110·5 | — | — | — | 75·9 | 79·2 | 96 | — | — | — |
| — | — | — | — | — | — | — | 75·1 | 70·8 | 106·1 | — | — | — | — | — | — | — | — | — |
| 40·5 | 32 | 33·5 | 51 | 39·5 | 69·6 | 68·1 | 69·6 | 68·1 | 102·3 | 80·6 | 44·9 | 78 | 82·7 | 77·4 | 93 | 62° | 73° | 45° |
| 47 | 39 | 40 | 49·5 | 35·5 | 73·7 | 66·1 | 73·3 | 65·8 | 111·3 | 84·3 | 34·5 | 85·7 | 85·1 | 71·7 | 93·5 | 62°·5 | 74°·5 | 43° |
| 40? | 34? | 33? | — | 38? | 74·4 | 66·1 | 74·4 | 66·1 | 112·6 | 69·5 | 47·9 | 85 | 82·5 | — | 84? | 62° | 81° | 37° |
| 45 | 32·5 | 32 | 53 | 38·5 | 75 | 73·9 | 75 | 73·9 | 101·5 | 71·3 | 52·9 | 72·2 | 71·1 | 72·6 | 105 | 70°·5 | 72°·5 | 37° |
| 42 | 32·5 | 33·5 | 44? | 35 | 74·3 | 68·7 | 73·5 | 68 | 108·1 | 69·3 | 53·9 | 79·3 | 79·8 | 79·5 | 91 | 66° | 76°·5 | 37°·5 |
| — | — | — | — | — | — | — | 74 | 67·3 | 109·9 | — | — | — | — | — | — | — | — | — |
| 42 | 33 | 33·5 | 47·5 | 33 | 74·2 | 75·3 | 73·7 | 74·9 | 98·5 | 77·3 | 42·2 | 76·7 | 79·8 | 69·5 | 94·5 | 64°·5 | 75° | 40°·5 |
| 42·5 | 30·5 | 30 | 43 | 39 | 75·5 | 74 | 75·5 | 74 | 102·1 | 63·3 | 51·6 | 72·6 | 70·6 | 90·7 | 96 | 67° | 78° | 35° |
| 46 | 30·5 | 30 | 50·5 | 39·5 | 76·3 | 67·7 | 76·8 | 68·1 | 112·7 | 70·8 | 46·9 | 67·8 | 65·2 | 78·2 | 101 | 71°·5 | 69° | 39°·5 |
| 40·5 | 34 | 34·5 | 43 | 33·5 | 73·6 | — | 73·2 | — | — | 79·3 | 51·5 | — | 85·2 | 77·9 | — | — | — | — |
| 40 | 34·5 | 34 | 45 | — | 78 | 69·2 | 77·2 | 68·5 | 112·7 | 77·5 | 41·5 | 85·2 | 85 | — | 93·5 | 64° | 74° | 42° |
| 37·5 | 31 | 31 | 40·5 | 31 | 77·8 | 71·6 | 77·3 | 71·2 | 108·6 | 64·5 | 48·8 | 81·6 | 82·7 | 76·5 | 81·5 | 64°·5 | 77°·5 | 38° |
| 40 | 31·5 | 30 | 46 | 35·5 | 79·5 | 74·3 | 79·5 | 74·3 | 107·1 | 76·7 | 52·2 | 79·7 | 75 | 77·2 | 97 | 69° | 71° | 40° |
| 44 | 36·5 | 35·5 | 53·5 | ? | 70·4 | 65·5 | 70·4 | 65·5 | 107·5 | 83·1 | 48·7 | 84·9 | 80·7 | — | 100·5 | 68° | 67° | 45° |
| 43 | 34 | 33 | 47 | 35 | 77·3 | 71·3 | 77·7 | 71·7 | 108·3 | 59·6 | 58·1 | 78·2 | 76·7 | 74·5 | 97 | 66°·5 | 79°·5 | 34° |
| 43·5 | 38 | 36 | 48 | 27·5 | 75·1 | 69·5 | 75·5 | 69·9 | 108 | 80·8 | 48·5 | 86·4 | 82·8 | 57·3 | 96·5 | 66°·5 | 69° | 44°·5 |
| 43 | 34·5 | 35 | 42·5 | 36 | 71 | 66·3 | 70·7 | 66 | 107·2 | 65·3 | 49·4 | 81·2 | 81·4 | 84·7 | 89 | 62° | 80° | 38° |

**7062—7088**: there are no skulls with these numbers in this series.

| E | | | | | Palate | | Indices | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $O_1$ | | $O_2$ | | | | | | | | | | | | | | | | |
| | L | R | L | R | $G_1$ | $G_2$ | B/L' | H/L' | B/L | H/L | B/H | G'H/GB | NB/NH | $O_2/O_1$ L | $O_2/O_1$ R | $G_2/G_1$ | GL | N ∠ | A |
| | 39·5 | 40 | 33 | 33 | — | 40 | 70·7 | 67·4 | 71·1 | 67·8 | 104·9 | 67·1 | 52·6 | 83·5 | 82·5 | — | 94 | 67° | 79° |
| | — | 43·5 | — | 32·5 | — | 38·5 | 80·9 | 72 | 80·9 | 72 | 112·5 | — | 54·1 | — | 74·7 | — | 96 | 65°·5 | 72° |
| | — | 43 | 35 | 36·5 | 49·5 | 35·5 | 70·4 | 65·3 | 70·4 | 65·3 | 107·9 | — | 44·2 | — | 84·9 | 71·7 | 92 | 63° | 71° |
| | 41 | 41 | 34 | 34 | 46 | 38·5 | 76·1 | 73·3 | 75·7 | 72·9 | 103·8 | 70·2 | 48·5 | 82·9 | 82·9 | 83·7 | 90·5 | 63°·5 | 78° |
| | 39·5 | — | 36·5 | — | 42·5 | 36·5 | 73·2 | 66·1 | 73·6 | 66·5 | 110·7 | — | 49 | 92·4 | — | 85·9 | 89·5 | 66° | 76° |
| | 44 | — | 34 | — | 50 | 31·5 | 79·1 | 71·1 | 79·1 | 71·1 | 111·2 | — | 43·5 | 77·3 | — | 63 | 90 | 58°·5 | 75° |
| | 45 | 45·5 | 34 | 33 | 44·5 | 36·5 | 75·7 | 63·8 | 75·7 | 63·8 | 118·6 | — | 46·1 | 75·6 | 72·5 | 82 | 91·5 | 64°·5 | 75° |
| | 43 | 42·5 | 36 | 35 | — | 31·5 | 72·6 | 67·6 | 71·8 | 66·8 | 107·4 | 79·5 | 45·9 | 83·7 | 82·3 | — | 87 | 63° | 74° |
| | 40·5 | 42 | 32 | 33 | 45 | 38·5 | 68·8 | 64 | 69·1 | 64·4 | 107·4 | 75 | 43·3 | 79 | 78·6 | 85·6 | 93 | 69° | 69° |
| | 42·5 | 41·5 | 34 | 34·5 | 43 | 35 | 77·3 | 69·1 | 76·9 | 68·7 | 112 | 81·5 | 47·9 | 80 | 83·1 | 81·4 | 85·5 | 61° | 74° |
| | — | 44 | — | 35 | 48·5 | — | 78·3 | 71·7 | 77·8 | 71·3 | 109 | — | 41·1 | — | 79·5 | — | 93·5 | 63° | 70° |
| | 41 | 40·5 | 32 | 32·5 | 46·5 | 37 | 73·4 | 70·7 | 73 | 70·4 | 103·7 | 80 | 45·2 | 78 | 80·2 | 79·6 | 97 | 64°·5 | 73° |
| | 41·5 | 40·5 | 33·5 | 34 | 47 | 42·5 | 77·1 | 66·5 | 76·2 | 65·7 | 116 | 81·3 | 40·7 | 80·7 | 83·9 | 90·4 | 96 | 68° | 66° |
| | 40 | 39 | 32 | 30·5 | 45·5 | — | 80 | 74·7 | 79·5 | 74·3 | 107·1 | 81·7 | 46·8 | 80 | 78·2 | — | 89·5 | 66° | 70° |
| | 41·5 | 43 | 32 | 33 | 48·5 | 36 | 70·6 | 69 | 69·9 | 68·3 | 102·3 | 70·6 | 53·3 | 77·1 | 76·7 | 74·2 | 95 | 69° | 74° |
| | 42 | 41 | 33·5 | 35 | 42·5 | 30 | 74·2 | 71·6 | 74·2 | 71·6 | 103·7 | 85·2 | 48·9 | 79·8 | 85·4 | 70·6 | 89·5 | 63° | 80° |
| | 42 | 42·5 | 33 | 33·5 | — | — | 74·3 | 65 | 74·3 | 65 | 114·3 | 74·4 | 49 | 78·6 | 78·8 | — | 92 | 67° | 73° |
| | 44 | 43·5 | 33·5 | 34 | 49·5 | 34·5 | 78·9 | 72·1 | 79·4 | 72·5 | 109·5 | 75·8 | 42·4 | 76·1 | 78·2 | 69·7 | 102 | 70° | 70° |
| | — | 39·5 | 31? | 30 | 48 | 38? | 77·5 | 70·2 | 77·1 | 69·8 | 110·5 | — | — | — | 75·9 | 79·2 | 96 | — | — |
| | — | — | — | — | — | — | — | — | 75·1 | 70·8 | 106·1 | — | — | — | — | — | — | — | — |
| | 41 | 40·5 | 32 | 33·5 | 51 | 39·5 | 69·6 | 68·1 | 69·6 | 68·1 | 102·3 | 80·6 | 44·9 | 78 | 82·7 | 77·4 | 93 | 62° | 73° |
| | 45·5 | 47 | 39 | 40 | 49·5 | 35·5 | 73·7 | 66·1 | 73·3 | 65·8 | 111·3 | 84·3 | 34·5 | 85·7 | 85·1 | 71·7 | 93·5 | 62°·5 | 74° |
| | 40? | 40? | 34? | 33? | — | 38? | 74·4 | 66·1 | 74·4 | 66·1 | 112·6 | 69·5 | 47·9 | 85 | 82·5 | — | 84? | 62° | 81° |
| | 45 | 45 | 32·5 | 32 | 53 | 38·5 | 75 | 73·9 | 75 | 73·9 | 101·5 | 71·3 | 52·9 | 72·2 | 71·1 | 72·6 | 105 | 70°·5 | 72° |
| | 41 | 42 | 32·5 | 33·5 | 44? | 35 | 74·3 | 68·7 | 73·5 | 68 | 108·1 | 69·3 | 53·9 | 79·3 | 79·8 | 79·5 | 91 | 66° | 76° |
| | — | — | — | — | — | — | — | — | 74 | 67·3 | 109·9 | — | — | — | — | — | — | — | — |
| | 43 | 42 | 33 | 33·5 | 47·5 | 33 | 74·2 | 75·3 | 73·7 | 74·9 | 98·5 | 77·3 | 42·2 | 76·7 | 79·8 | 69·5 | 94·5 | 64°·5 | 75° |
| | 42 | 42·5 | 30·5 | 30 | 43 | 39 | 75·5 | 74 | 75·5 | 74 | 102·1 | 63·3 | 51·6 | 72·6 | 70·6 | 90·7 | 96 | 67° | 78° |
| | 45 | 46 | 30·5 | 30 | 50·5 | 39·5 | 76·3 | 67·7 | 76·8 | 68·1 | 112·7 | 70·8 | 46·9 | 67·8 | 65·2 | 78·2 | 101 | 71°·5 | 69° |
| | — | 40·5 | 34 | 34·5 | 43 | 33·5 | 73·6 | — | 73·2 | — | — | 79·3 | 51·5 | — | 85·2 | 77·9 | — | — | — |
| | 40·5 | 40 | 34·5 | 34 | 45 | — | 78 | 69·2 | 77·2 | 68·5 | 112·7 | 77·5 | 41·5 | 85·2 | 85 | — | 93·5 | 64° | 74° |
| | 38 | 37·5 | 31 | 31 | 40·5 | 31 | 77·8 | 71·6 | 77·3 | 71·2 | 108·6 | 64·5 | 48·8 | 81·6 | 82·7 | 76·5 | 81·5 | 64°·5 | 77° |
| | 39·5 | 40 | 31·5 | 30 | 46 | 35·5 | 79·5 | 74·3 | 79·5 | 74·3 | 107·1 | 76·7 | 52·2 | 79·7 | 75 | 77·2 | 97 | 69° | 71° |
| | 43 | 44 | 36·5 | 35·5 | 53·5 | ? | 70·4 | 65·5 | 70·4 | 65·5 | 107·5 | 83·1 | 48·7 | 84·9 | 80·7 | — | 100·5 | 68° | 67 |
| | 43·5 | 43 | 34 | 33 | 47 | 35 | 77·3 | 71·3 | 77·7 | 71·7 | 108·3 | 59·6 | 58·1 | 78·2 | 76·7 | 74·5 | 97 | 66°·5 | 79 |
| | 44 | 43·5 | 38 | 36 | 48 | 27·5 | 75·1 | 69·5 | 75·5 | 69·9 | 108 | 80·8 | 48·5 | 86·4 | 82·8 | 57·3 | 96·5 | 66°·5 | 69 |
| | 42·5 | 43 | 34·5 | 35 | 42·5 | 36 | 71 | 66·3 | 70·7 | 66 | 107·2 | 65·3 | 49·4 | 81·2 | 81·4 | 84·7 | 89 | 62° | 80 |

**7062—7088**: there are no skulls with these numbers in this series.

# TABLE VII.

| GL | Angles | | | | | | Remarks |
|---|---|---|---|---|---|---|---|
| | $N\angle$ | $A\angle$ | $B\angle$ | $\theta_2$ | $\theta_1$ | $P\angle$ | |
| 94 | 67° | 79° | 34° | 8° | 26° | 87° | cal. senile |
| 96 | 65°·5 | 72° | 42°·5 | 11° | 31°·5 | 83° | cal. ad. left side of face defective. metopic. bathrocephalic; numerous ossicles in lambdoid suture |
| 92 | 63° | 71° | 46° | 19° | 27° | 90° | cal. y. ad.? l. malar defect. strongly bathrocephalic, numerous ossicles in λ |
| 90·5 | 63°·5 | 78°·5 | 38° | 7°·5 | 30°·5 | 86° | cal. ad. small defect in r. frontal. metopic. slight occipital projection. bilateral pterygo-spinous bridge. faint coronal depression on r. side |
| 89·5 | 66° | 76° | 38° | 14° | 24° | 90°? | cal. old. r. malar defect. post coronal depression. slight bathrocephaly. wormians in lambdoid suture, one on l., two on r., one in parietal notch of temporal on each side. infantile forehead |
| 90 | 58°·5 | 75°·5 | 46° | 17°·5 | 28°·5 | 93° | cal. old. r. malar defect. inion strongly marked |
| 91·5 | 64°·5 | 75° | 40°·5 | 14° | 26°·5 | 89° | cal. old. frontal, occipital and zygomatic defects |
| 87 | 63° | 74° | 43° | 13° | 30° | 87° | cal. old. r. zygomatic defect |
| 93 | 69° | 69° | 42° | 16° | 26° | 85° | cal. y. ad. l. zygomatic and r. temporal defects. sagittal suture absent, coronal and lambdoid sutures open; hyperdolichocephalic, slight coronal depression |
| 85·5 | 61° | 74° | 45° | 17°·5 | 27°·5 | 91°·5 | cal, ad. |
| 93·5 | 63° | 70° | 47° | 17° | 30° | 87° | cal. ad. l. malar defect. ossicles in lambdoid suture |
| 97 | 64°·5 | 73°·5 | 42° | 11°·5 | 30°·5 | 85° | cal. ad. (? old). minute ossicles in lambdoid suture. inion well marked |
| 96 | 68° | 66°·5 | 45°·5 | 18°·5 | 27° | 85° | cal. ad. l. zygomatic arch broken. ossicle of pterion. tripartite interparietal bone. *torus occipitalis* |
| 89·5 | 66° | 70°·5 | 43°·5 | 15° | 28°·5 | 85°·5 | cal. ad. groove of obelion, traces of ossicle of λ. l. ossicle of pterion. slight *torus occipitalis* |
| 95 | 69° | 74°·5 | 36°·5 | 8°·5 | 28° | 83° | cal. y. ad. |
| 89·5 | 63° | 80° | 37° | 8° | 29° | 88° | cal. ad. l. zygomatic defect. ossicles of asterion, r. 18 × 15 mm., l. 11 × 11 mm. inion well de- |
| 92 | 67° | 73°·5 | 39°·5 | 14°·5 | 25° | 88° | cal. ad. (? old). r. zygomatic defect [veloped |
| 102 | 70° | 70° | 40° | 12° | 28° | 82° | cal. ad. large r. temporal and orbital defect |
| 96 | — | — | — | — | — | 89°? | cal. old. frontal and l. facial defects. slight groove of obelion. *torus occipitalis*. ossicles of lambdoid suture |
| — | — | — | — | — | — | — | cal.–f. ad. r. temporal defect. ossicle 20 × 17 mm. in l. lambdoid suture |
| 93 | 62° | 73° | 45° | 16° | 29° | 89° | cal. ad. (? y. ad.). slight post coronal depression. frontal process of squamous on both sides |
| 93·5 | 62°·5 | 74°·5 | 43° | 13°·5 | 29°·5 | 88° | cal. old. r. coronal groove. metopic |
| 84? | 62° | 81° | 37° | 10° | 27° | 91°? | cal. senile. l. temporal and occipital defects. slight post coronal depression. r. occipital flattening |
| 105 | 70°·5 | 72°·5 | 37° | 8°·5 | 28°·5 | 81° | cal. old. traces of ossicle of bregma |
| 91 | 66° | 76°·5 | 37°·5 | 8°·5 | 29° | 85° | cal. old. r. zygomatic and occipital defects |
| — | — | — | — | — | — | — | cal.–f. old. extensive temporo-sphenoidal defect. marked bathrocephaly. numerous ossicles of λ and parieto-mastoid sutures. ossicle 12 × 12 mm. in r. coronal. slight *torus occipitalis* |
| 94·5 | 64°·5 | 75° | 40°·5 | 11° | 29°·5 | 86° | cal. old. l. temporal and r. zygomatic defects |
| 90 | 67° | 78° | 35° | 8° | 27° | 86° | cal. ad. healed fracture crossing hinder part l. parietal. faint *torus occipitalis* |
| 101 | 71°·5 | 69° | 39°·5 | 14° | 25°·5 | 83° | cal. ad. (? y. ad.). post coronal depression. bulging of temporal portion of coronal suture on either side |
| — | — | — | — | — | — | 87° | cal. y. ad. large basal and l. malar defects |
| 93·5 | 64° | 74° | 42° | 12° | 30° | 86° | cal. ad. metopic. faint depression of obelion |
| 81·5 | 64°·5 | 77°·5 | 38° | 7°·5 | 30°·5 | 85° | cal. ad. |
| 97 | 69° | 71° | 40° | 10° | 30° | 81° | cal. ad. l. temporal defect. metopic. post coronal depression. small r. ossicle of pterion and small ossicles in lambdoid suture |
| 100·5 | 68° | 67° | 45° | 18° | 27° | 85° | cal. ad. l. zygoma defective |
| 97 | 66°·5 | 79°·5 | 34° | — | — | — | cal. old. occipito-parietal defect |
| 96 5 | 66°·5 | 69° | 44°·5 | 14° | 30°·5 | 83° | cal. ad. |
| 89 | 62° | 80° | 38° | 6° | 32° | 86° | cal. old. defective l. zygoma. edentulous save for retained r. canine. post coronal constriction. *torus occipitalis* |

| Series No. | Sex | C | Lengths F | L' | L | B | B' | H | OH | LB | Circumferences U | S | Q | Face G'H | GB | J | NH | NB | $O_1$ L | R | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7121 | ♂? | 1575 | 193 | 193 | 193 | 144 | 97 | 136 | 116 | 101 | 534 | 395 | 315 | 63 | 86 | 128 | 47·5 | 24 | 43 | 43·5 | 32 |
| 7122 | ♂ | — | 189 | 193 | 193 | 141 | 94 | 131 | 119 | 103 | 533 | 390 | 320 | 70 | 87 | 123 | 54 | 25·5 | 39·5 | 40 | 33 |
| 7123 | ♂ | — | 197 | 197 | 198 | 145 | 100 | 138 | 117 | 96 | 545 | — | 316 | 71 | 98 | 123 | 50·5 | 23·5 | — | 44·5 | 33 |
| 7124 | ♂ | 1?75 | ·83 | 188 | 189 | 141 | 99 | 129 | 112 | 102 | 515 | 369 | 300 | 69 | — | — | 52·5 | — | 43 | — | 33 |
| 7125 | ♀ | 1335 | 179 | 177 | 179 | 138 | 94 | 129 | 113 | 98 | 507 | 361 | 303 | — | — | — | 52 | — | 43·5 | — | 31 |
| 7126 | ♀ | 1255 | 181 | 183 | 183 | 134 | 92 | 124 | 102 | 102 | 501 | 349 | 281 | 66·5 | 89 | 127 | 50 | 23 | 42 | 41·5 | 31 |
| 7127 | ♂ | — | 196 | 196 | 197 | — | 100 | 137 | 119 | — | — | 388 | — | 68 | 88 | — | 49 | 27 | 45 | — | 35 |

| Series No. | $W_1$ | $W_2$ | $h_1$ | f |
|---|---|---|---|---|
| 1 | 111 | 87 | — | 46·5 |
| 2 | 109 | 94 | 27·5 | 44 |
| 3 | — | — | 33 | 47 |
| 4 | 115 | 104·5 | 29·5 | 41 |
| 5 | — | 117 | 35·5 | 47 |
| 6 | 123 | 105 | 37·5 | 46·5 |
| 7 | — | — | 34·5 | 39·5 |
| 8 | 110 | 102 | 28? | 43 |
| 9 | — | 85 | 33·5? | 39·5 |
| 10 | 106 | 86·5 | 30 | 48 |
| 11 | — | 95·5 | 30·5 | 44 |
| 12 | 127 | 105 | — | 45 |
| 13 | — | — | 29? | 47 |
| 14 | — | — | 30 | 44 |
| 15 | 114 | 97 | 28 | 41 |
| 16 | 124 | 98 | 33·5 | 48 |
| 17 | 107 | 95·5 | 27·5 | 40·5 |
| 18 | — | — | 33? | 48 |
| 19 | — | 90 | 29 | 41·5 |
| 20 | 102·5? | 87 | 30 | 41·5 |
| 21 | 108 | 92·5 | 31 | 42·5 |
| 22 | 111 | 91 | 28 | 41 |
| 23 | 115·5 | 109 | 25·5 | 45 † 44 |
| 24 | 121·5 | 98 | 31·5 | 44·5 |
| 25 | 103·5 | 89 | 35·5 | 42 |
| 26 | — | 89 | 25·5 | 44 |
| 27 | 123 | 105·5 | 31 | 42 |
| 28 | 111·5 | 97 | 24·5 | 46·5 |
| 29 | 113·5 | 94 | 36 | 40·5 |
| 30 | 118 | 89·5 | 31·5 | 45·5 |
| 31 | — | 88·5 | 31? | 40 |
| 32‡ | 97·5 | 77·5 | 23? | 40·5 |
| 33 | — | 97 | — | 41 |
| 34 | 111 | 99 | 35 | 41·5 |
| 35 | 115 | 91 | — | 43·3 |

| Series No. | $W_1$ | $W_2$ | $h_1$ | f |
|---|---|---|---|---|
| 36 | 119 | 96 | — | 47·5 |
| 37 | 112·5 | 90 | 27·5 | 43 |
| 38 | 120 | 87·5 | 29 | 45·5 |
| 39 | — | — | 39·5 | 43 |
| 40 | 126 | 94 | 34·5? | 42·5 |
| 41‡ | 85 | 76·5 | 24·5 | 35·5 |
| 42 | 108 | 84 | 28 | 42 |
| 43 | 110·5 | 104 | 32 | 44 |
| 44 | 104 | 80·5 | 24·5 | 43·5 |
| 45 | 120? | 97 | 34 | 43 |
| 46 | — | — | 39·5 | 48·5 |
| 47 | 112 | 93 | 31·5 | 43 |
| 48 | — | — | 24·5 | 41 |
| 49 | — | 92 | 33·5? | 41 |
| 50 | — | 108·5 | 30? | 45 |
| 51 | 119·5 | 108·5 | — | 45·5 |
| 52 | 104? | 87 | — | 44·5 |
| 53 | 111·5 | 90·5 | — | 42 |
| 54 | 118 | 92? | — | 46·5 |
| 55 | 120 | 90·5? | 31·5 | 45 |
| 56 | — | 96·5? | 30 | 45 |
| 57 | 108? | 98·5 | 29 | 45·5 |
| 58 | 118 | 100·5 | 32 | 45 |
| 59 | 114·5 | 85 | 27·5 | 45·5 |
| 60 | 113? | 90·5 | 34·5 | 40 |
| 61 | 113 | 109·5 | 30? | 50 |
| 62 | 112·5 | 99·5 | 28·5 | 44 |
| 63 | 110 | 98 | 30? | 42·5 |
| 64 | 109 | 86·5 | — | 43 |
| 65 | — | — | 31·5 | 45 |
| 66 | 118·5 | 91·5 | 31·5 | 41 |
| 67 | 123·5 | 100 | 30·5 | 43 |
| 68 | 117 | — | 26 | 46·5 |
| 69 | 112 | 100·5 | 36 | 42·5 |
| 70 | 107·5 | 92 | 32·5 | 43·5 |
| 71 | 109? | 81·5 | 26? | 40·5 |

* These mandibles, when the bones were dug up, were unfortunately not kept with t

† *foramen mentale* double on

| $O_1$ L | $O_1$ R | $O_2$ L | $O_2$ R | Palate $G_1$ | Palate $G_2$ | Indices $B/L'$ | $H/L'$ | $B/L$ | $H/L$ | $B/H$ | $G'H/GB$ | $NB/NH$ | $O_2/O_1$ L | $O_2/O_1$ R | $G_2/G_1$ | $GL$ | $N$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 43·5 | 32 | 31·5 | 44 | 38 | 74·6 | 70·5 | 74·6 | 70·5 | 105·9 | 73·3 | 50·5 | 74·4 | 72·4 | 86·4 | 90 | 6 |
| 9·5 | 40 | 33·5 | 33 | 45 | 40 | 73·1 | 67·9 | 73·1 | 67·9 | 107·6 | 80·5 | 47·2 | 84·8 | 82·5 | 88·9 | 90 | 5 |
| — | 44·5 | 33 | 32·5 | 49 | 38·5 | 73·6 | 70 | 73·2 | 69·7 | 105 | 72·4 | 46·5 | — | 73 | 78·6 | 89? | 6 |
| 3 | — | 33 | — | 55 | — | 75 | 68·6 | 74·6 | 68·2 | 109·3 | — | — | 76·7 | — | — | 99 | 6 |
| 3·5 | — | 31·5 | — | — | — | 78 | 72·9 | 77·1 | 72·1 | 106·9 | — | — | 72·4 | — | — | — | |
| 2 | 41·5 | 31 | 32·5 | 47·5 | 36·5 | 73·2 | 67·8 | 73·2 | 67·8 | 108·1 | 74·7 | 46 | 73·8 | 78·3 | 76·8 | 96 | 6 |
| 5 | — | 35 | 36 | 50·5 | 36 | — | 69·9 | — | 69·5 | — | 77·3 | 55·1 | 77·8 | — | 71·3 | — | |

## MANDIBLES*.

| | $h_1$ | $f$ |
|---|---|---|
| | — | 47·5 |
| | 27·5 | 43 |
| | 29 | 45·5 |
| | 39·5 | 43 |
| | 34·5? | 42·5 |
| | 24·5 | 35·5 |
| | 28 | 42 |
| | 32 | 44 |
| | 24·5 | 43·5 |
| | 34 | 43 |
| | 39·5 | 48·5 |
| | 31·5 | 43 |
| | 24·5 | 41 |
| | 33·5? | 41 |
| | 30? | 45 |
| | — | 45·5 |
| | — | 44·5 |
| | — | 42 |
| | — | 46·5 |
| ? | 31·5 | 45 |
| ? | 30 | 45 |
| | 29 | 45·5 |
| | 32 | 45 |
| | 27·5 | 45·5 |
| | 34·5 | 40 |
| | 30? | 50 |
| | 28·5 | 44 |
| | 30? | 42·5 |
| | — | 43 |
| | 31·5 | 45 |
| | 31·5 | 41 |
| | 30·5 | 43 |
| | 26 | 46·5 |
| | 36 | 42·5 |
| | 32·5 | 43·5 |
| | 26? | 40·5 |

| Series No. | $W_1$ | $W_2$ | $h_1$ | $f$ |
|---|---|---|---|---|
| 72 | — | 89? | — | 42·5 |
| 73 | 115 | 91 | 30·5 | 44·5 |
| 74 | — | 90·5 | — | 38·5 |
| 75 | 112·5 | 108·5 | — | 46 |
| 76 | 111·5 | 93 | 27·5 | 46·5 |
| 77 | 114 | 91·5 | 29·5 | 45 |
| 78 | — | 105 | 39 | 45·5 |
| 79 | 119·5 | 85 | 31? | 41·5 |
| 80 | 112 | 99·5 | 35 | 44 |
| 81 | 114·5 | 95 | 27 | 35 |
| 82 | 105·5 | 91 | 30·5 | 44 |
| 83 | 121 | 99·5 | 32·5 | 45 |
| 84 | — | 85 | 27·5? | 40 |
| 85 | — | — | 30 | 46 |
| 86 | — | — | 31 | 43·5 |
| 87 | 104·5 | 90 | 36 | 41·5 |
| 88 | 114·5 | 90·5 | 32·5 | 46·5 |
| 89 | — | 96·5 | — | 46·5 |
| 90 | 116 | 97 | 35 | 42 |
| 91 | — | 111·5 | — | 48·5 |
| 92§ | 81 | 68 | 20 | 34·5 |
| 93 | 113 | 104? | — | 49 |
| 94 | — | 95·5 | 30 | 39·5 |
| 95 | 106·5 | 92 | 29 | 43 |
| 96 | — | 103 | 35 | 47 |
| 97 | 119 | 95 | — | 43·5 |
| 98 | 108·5 | 97 | — | 44 |
| 99 | 121·5 | 116 | 32 | 45 |
| 100 | 111 | 83 | 29 | 44·5 |
| 101 | — | 113 | 31 | 43 |
| 102 | — | 95 | — | 46 |
| 103§ | — | 70 | 21·5 | 36·5 |
| 104 | 109 | 88 | 24 | 41·5 |
| 105 | 111·5 | 89·5 | 29 | 44 |
| 106 | 114·5 | 95·5? | 33 | 43·5 |
| 107 | 119·5 | 88·5 | 29·5 | 46 |

| Series No. | $W_1$ | $W_2$ | $h_1$ | $f$ |
|---|---|---|---|---|
| 108 | 118 | — | 34·5? | 45 |
| 109 | — | 95·5 | 33 | 44·5 |
| 110 | 119·5 | 99·5 | 32·5? | 41 |
| 111 | — | 106·5 | 27·5 | 50 |
| 112 | — | 104? | — | 46·5 |
| 113 | — | 93? | 33·5 | 43 |
| 114 | 119·5 | 97 | 32 | 43 |
| 115 | — | — | 30 | 45·5 |
| 116 | — | — | — | 42 |
| 117§ | — | — | — | 37 |
| 118 | — | 85·5? | — | 41·5 |
| 119 | 106·5? | 86 | 22·5 | 43·5 |
| 120 | — | 90 | 25 | 43 |
| 121 | — | 111·5 | 32 | 48 |
| 122 | — | 114 | — | 49·5 |
| 123 | 119·5 | 90 | — | 42·5 |
| 124 | — | — | 32·5 | 42 |
| 125 | 116 | 101·5 | 32·5 | 45·5 |
| 126 | — | 110 | — | 43·5 |
| 127 | 101? | 81·5? | 27·5 | 39·5 |
| 128 | 119 | 89 | 26 | 47 |
| 129 | 105·5 | 85·5 | — | 42·5 |
| 130 | 118·5 | 102·5? | 30 | 45·5 |
| 131 | 105·5 | 88 | 27? | 42·5 |
| 132 | 102·5? | 87? | 33 | 41 |
| 133 | — | 90·5 | 34·5 | 39 |
| 134 | 96·5? | 82 | 24·5 | 39 |
| 135 | 126 | 117 | — | 50 |
| 136 | 110 | 85·5 | — | 42·5 |
| 137 | 105·5 | 94 | 29 | 43·5 |
| 138 | 102·5 | 99·5 | 30? | 41·5 |
| 139 | 105·5 | 92 | 24·5 | 41 |
| 140 | 114·5 | 97·5 | — | 41·5 |
| 141 | 113 | 90·5 | — | 41·5 |
| 142 | — | 101 | 32? | 44·5 |
| 143 | — | 85 | — | 43 |

y not kept with their particular crania and as it has not been found possible to satisfactorily sex the great bulk of them, n

*entale* double on left. ‡ Young adult. § Infantile.

| | | | | | Palate | | Indices | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $O_1$ | | $O_2$ | | | | | | | | | | | | | | | | |
| *L* | *R* | *L* | *R* | $G_1$ | $G_2$ | *B*/*L*′ | *H*/*L*′ | *B*/*L* | *H*/*L* | *B*/*H* | *G*′*H*/*GB* | *NB*/*NH* | $O_2/O_1$ *L* | $O_2/O_1$ *R* | $G_2/G_1$ | *GL* | *N* ∠ | |
| 43 | 43·5 | 32 | 31·5 | 44 | 38 | 74·6 | 70·5 | 74·6 | 70·5 | 105·9 | 73·3 | 50·5 | 74·4 | 72·4 | 86·4 | 90 | 61° | 8 |
| 39·5 | 40 | 33·5 | 33 | 45 | 40 | 73·1 | 67·9 | 73·1 | 67·9 | 107·6 | 80·5 | 47·2 | 84·8 | 82·5 | 88·9 | 90 | 59° | 7 |
| — | 44·5 | 33 | 32·5 | 49 | 38·5 | 73·6 | 70 | 73·2 | 69·7 | 105 | 72·4 | 46·5 | — | 73 | 78·6 | 89? | 62°·5 | 7 |
| 43 | — | 33 | — | 55 | — | 75 | 68·6 | 74·6 | 68·2 | 109·3 | — | — | 76·7 | — | — | 99 | 67°·5 | 7 |
| 43·5 | — | 31·5 | — | — | — | 78 | 72·9 | 77·1 | 72·1 | 106·9 | — | — | 72·4 | — | — | — | — | |
| 42 | 41·5 | 31 | 32·5 | 47·5 | 36·5 | 73·2 | 67·8 | 73·2 | 67·8 | 108·1 | 74·7 | 46 | 73·8 | 78·3 | 76·8 | 96 | 65°·5 | 7 |
| 45 | — | 35 | 36 | 50·5 | 36 | — | 69·9 | — | 69·5 | — | 77·3 | 55·1 | 77·8 | — | 71·3 | — | — | |

## MANDIBLES*.

| $V_2$ | $h_1$ | *f* |
|---|---|---|
| | — | 47·5 |
| | 27·5 | 43 |
| ·5 | 29 | 45·5 |
| — | 39·5 | 43 |
| | 34·5? | 42·5 |
| ·5 | 24·5 | 35·5 |
| | 28 | 42 |
| | 32 | 44 |
| ·5 | 24·5 | 43·5 |
| | 34 | 43 |
| — | 39·5 | 48·5 |
| | 31·5 | 43 |
| — | 24·5 | 41 |
| | 33·5? | 41 |
| ·5 | 30? | 45 |
| ·5 | — | 45·5 |
| | — | 44·5 |
| ·5 | — | 42 |
| ? | — | 46·5 |
| ·5? | 31·5 | 45 |
| ·5? | 30 | 45 |
| ·5 | 29 | 45·5 |
| ·5 | 32 | 45 |
| | 27·5 | 45·5 |
| ·5 | 34·5 | 40 |
| ·5 | 30? | 50 |
| ·5 | 28·5 | 44 |
| | 30? | 42·5 |
| ·5 | — | 43 |
| — | 31·5 | 45 |
| ·5 | 31·5 | 41 |
| | 30·5 | 43 |
| — | 26 | 46·5 |
| ·5 | 36 | 42·5 |
| | 32·5 | 43·5 |
| ·5 | 26? | 40·5 |

| Series No. | $W_1$ | $W_2$ | $h_1$ | *f* |
|---|---|---|---|---|
| 72 | — | 89? | — | 42·5 |
| 73 | 115 | 91 | 30·5 | 44·5 |
| 74 | — | 90·5 | — | 38·5 |
| 75 | 112·5 | 108·5 | — | 46 |
| 76 | 111·5 | 93 | 27·5 | 46·5 |
| 77 | 114 | 91·5 | 29·5 | 45 |
| 78 | — | 105 | 39 | 45·5 |
| 79 | 119·5 | 85 | 31? | 41·5 |
| 80 | 112 | 99·5 | 35 | 44 |
| 81 | 114·5 | 95 | 27 | 35 |
| 82 | 105·5 | 91 | 30·5 | 44 |
| 83 | 121 | 99·5 | 32·5 | 45 |
| 84 | — | 85 | 27·5? | 40 |
| 85 | — | — | 30 | 46 |
| 86 | — | — | 31 | 43·5 |
| 87 | 104·5 | 90 | 36 | 41·5 |
| 88 | 114·5 | 90·5 | 32·5 | 46·5 |
| 89 | — | 96·5 | — | 46·5 |
| 90 | 116 | 97 | 35 | 42 |
| 91 | — | 111·5 | — | 48·5 |
| 92§ | 81 | 68 | 20 | 34·5 |
| 93 | 113 | 104? | — | 49 |
| 94 | — | 95·5 | 30 | 39·5 |
| 95 | 106·5 | 92 | 29 | 43 |
| 96 | — | 103 | 35 | 47 |
| 97 | 119 | 95 | — | 43·5 |
| 98 | 108·5 | 97 | — | 44 |
| 99 | 121·5 | 116 | 32 | 45 |
| 100 | 111 | 83 | 29 | 44·5 |
| 101 | — | 113 | 31 | 43 |
| 102 | — | 95 | — | 46 |
| 103§ | — | 70 | 21·5 | 36·5 |
| 104 | 109 | 88 | 24 | 41·5 |
| 105 | 111·5 | 89·5 | 29 | 44 |
| 106 | 114·5 | 95·5? | 33 | 43·5 |
| 107 | 119·5 | 88·5 | 29·5 | 46 |

| Series No. | $W_1$ | $W_2$ | $h_1$ | *f* |
|---|---|---|---|---|
| 108 | 118 | — | 34·5? | 45 |
| 109 | — | 95·5 | 33 | 44·5 |
| 110 | 119·5 | 99·5 | 32·5? | 41 |
| 111 | — | 106·5 | 27·5 | 50 |
| 112 | — | 104? | — | 46·5 |
| 113 | — | 93? | 33·5 | 43 |
| 114 | 119·5 | 97 | 32 | 43 |
| 115 | — | — | 30 | 45·5 |
| 116 | — | — | — | 42 |
| 117§ | — | — | — | 37 |
| 118 | — | 85·5? | — | 41·5 |
| 119 | 106·5? | 86 | 22·5 | 43·5 |
| 120 | — | 90 | 25 | 43 |
| 121 | — | 111·5 | 32 | 48 |
| 122 | — | 114 | — | 49·5 |
| 123 | 119·5 | 90 | — | 42·5 |
| 124 | — | — | 32·5 | 42 |
| 125 | 116 | 101·5 | 32·5 | 45·5 |
| 126 | — | 110 | — | 43·5 |
| 127 | 101? | 81·5? | 27·5 | 39·5 |
| 128 | 119 | 89 | 26 | 47 |
| 129 | 105·5 | 85·5 | — | 42·5 |
| 130 | 118·5 | 102·5? | 30 | 45·5 |
| 131 | 105·5 | 88 | 27? | 42·5 |
| 132 | 102·5? | 87? | 33 | 41 |
| 133 | — | 90·5 | 34·5 | 39 |
| 134 | 96·5? | 82 | 24·5 | 39 |
| 135 | 126 | 117 | — | 50 |
| 136 | 110 | 85·5 | — | 42·5 |
| 137 | 105·5 | 94 | 29 | 43·5 |
| 138 | 102·5 | 99·5 | 30? | 41·5 |
| 139 | 105·5 | 92 | 24·5 | 41 |
| 140 | 114·5 | 97·5 | — | 41·5 |
| 141 | 113 | 90·5 | — | 41·5 |
| 142 | — | 101 | 32? | 44·5 |
| 143 | — | 85 | — | 43 |

ely not kept with their particular crania and as it has not been found possible to satisfactorily sex the great bulk of them, no sta

*mentale* double on left. ‡ Young adult. § Infantile.

## TABLE VIII.

| | Angles | | | | | | Remarks |
|---|---|---|---|---|---|---|---|
| *GL* | *N* ∠ | *A* ∠ | *B* ∠ | $\theta_2$ | $\theta_1$ | *P* ∠ | |
| 90 | 61° | 81° | 38° | 9° | 29° | 90° | cal. ad. strongly marked inion |
| 90 | 59° | 79° | 42° | 1?° | 25° | 96° | cal. old. r. parietal defect. slight *torus occipitalis* |
| 89? | 62°·5 | 73° | 44°·5 | 11° | 33°·5 | 84°? | cal. ad. large r. occipital and l. malar defects. healed depressed fracture in l. parietal. ossicles in lambdoid suture |
| 99 | 67°·5 | 72°·5 | 40° | 11°·5 | 28°·5 | 84° | cal. ad. r. side of face very defective. plagiocephalic. r. occipital and l. frontal flattening. inion prominent |
| — | — | — | — | — | — | — | cal. ad. r. half of face wanting |
| 96 | 65°·5 | 75°·5 | 39° | 8°·5 | 30°·5 | 84° | cal. ad. l. zygomatic defect. ossicles in lambdoid suture. rather prominent inion |
| — | — | — | — | — | — | 86° | cal. ad. large r. temporal defect and transverse fracture of base. traces of transverse occipital suture |

| *f* |
|---|
| 5 |
| 4·5 |
| 1 |
| 0 |
| 6·5 |
| 3 |
| 3 |
| 5·5 |
| 2 |
| 7 |
| 1·5 |
| 3·5 |
| 3 |
| 8 |
| 9·5 |
| 2·5 |
| 2 |
| 5·5 |
| 3·5 |
| 9·5 |
| 7 |
| 2·5 |
| 5·5 |
| 2·5 |
| 1 |
| 9 |
| 9 |
| 0 |
| 2·5 |
| 3·5 |
| 1·5 |
| 1 |
| 1·5 |
| 1·5 |
| 4·5 |
| 3 |

| Series No. | $W_1$ | $W_2$ | $h_1$ | *f* |
|---|---|---|---|---|
| 144 | 112 | 97 | — | 44 |
| 145 | 118·5 | 98 | — | 43·5 |
| 146‡ | 103·5 | 85·5 | 29 | 40·5 |
| 147 | — | 112·5 | 34 | 46·5 |
| 148 | 115 | 82 | 31·5 | 39·5 |
| 149 | — | 90 | 22·5 | 41 |
| 150 | 120 | 102·5 | — | 47 |
| 151 | — | 88 | 27 | 40 |
| 152 | — | 73·5 | 23·5 | 35 |
| 153 | 113·5 | 96·5 | — | 44 |
| 154 | 107 | 86·5 | 27 | 40 |
| 155 | — | 95 | 35 | 40·5 |
| 156 | — | — | 34 | 44 |
| 157 | 110 | 89 | 28? | 41 |
| 158 | — | 108 | — | 45·5 |
| 159 | 113·5 | 90 | 30 | 46 |
| 160 | 109 | 90 | 35 | 40·5 |
| 161 | 120 | 98 | 31 | 45 |
| 162 | 102 | 86 | 28·5 | 41 |
| 163 | 110 | 96 | 31·5 | 43·5 |
| 164 | — | — | 29·5 | 41·5 |
| 165 | 116 | 102 | 34·5 | 48·5 |
| 166‡ | 91 | 87 | 23 | 40 |
| 167 | — | 92? | 25? | 47 |
| 168 | 112 | 96 | 34·5 | 43·5 |
| 169 | — | — | — | 45·5 |
| 170 | — | 106·5 | 33·5 | 46·5 |
| 171 | — | 103·5 | 35·5 | 45 |
| 172 | — | 92? | — | 44 |
| 173 | 107? | 87 | 30 | 42·5 |
| 174 | — | 107·5 | 31·5 | 45 |
| 175 | — | 102 | 35·5 | 45 |
| 176 | — | — | 24 | 37·5 |
| 177 | — | 117 | 37·5 | 48·5 |
| 178 | 130 | 94·5 | 38 | 43·5 |

‡ of them, no statement as to sex has been made.

# ON INHERITANCE OF COAT-COLOUR IN THE GREYHOUND.

By AMY BARRINGTON, ALICE LEE, and KARL PEARSON.

(1) *Introductory.* There is little doubt that if money and time were no consideration direct experiments on the breeding of dogs would lead to results of the highest importance not only for the theory of inheritance, but also for the practical guidance of dog-fanciers. To be of the most complete service such experiments would have to commence with two or three generations of in-breeding simply to insure the purity of the various stocks to be employed in the final experiments*. Further, in the description of the selected characters, a classification would have to be adopted of a far more comprehensive character than appears to be usual in a number of recent experiments on hybridisation. Lastly, from the standpoint which we believe to be the correct one, that safe conclusions can only be drawn from the average of large numbers of crossings, at least 50 and probably 100 individuals of both sexes would have to be the basis of an effective experimental stud†. Now the difficulty both in time and money of dealing with such a stud may not in the future be insuperable, but at present to propose it as the only means of approaching the problem of inheritance in dogs is to adjourn *sine die* any consideration of that problem. In certain points also the extensive breeding records which are already available for dogs possess advantages which are not to be wholly disregarded when we compare them with the special merits of a biometric stud-farm. In the first place we have all the gain which arises from dealing with literally immense numbers. For example, in the present memoir we were able to classify over 10,000 cases of parent and

* For example when this is wanting, we find as in the case of some recent experiments on rabbits, inconclusive results reached, because the judgment of purity is based on *a posteriori* examination of the experimental litter, judgment which might be, and actually was in certain cases, reversed on the appearance of a second litter from the same pair.

† 10 offspring of each of 50 hybridisations give an incomparably more valuable result than the 100 offspring of one or two hybridisations to which we are frequently treated.

offspring, over 7000 cases of grandparent and offspring, and over 24,000 cases of siblings. Nothing approaching such totals could be obtained by experiment *ad hoc*. Further, the colour pedigrees for a number of generations were directly available. Against these advantages is to be put in the foremost place the primary value of exactitude and uniformity in record such as might be obtained in a well organised scientific experiment. This counts for a great deal, but it does not count for everything with those who realise what are the probable errors of small series, and how inconclusive such series usually are*. On the other hand also, if we admit the want of scientific exactness and the play of individual judgment in the character classifications of breeders, we have still to remember that when the breeding of a particular species has been long established a conventional scale also grows up which, owing to the contact of breeder with breeder at sales and shows, and further to the regulations of societies and judges, becomes within broad lines universally recognised and appreciated. Hence, while we fully recognise all the disadvantages of stud-book records, we still hold that highly valuable work may be done in the field of inheritance by accepting the classification of professional, if non-scientific breeders.

So far as we are aware no series of dogs has been dealt with or at least any results for such a series published since Mr Francis Galton's work on Basset Hounds†. We have long felt that that work needed supplementing, partly because it dealt with a rather small group of much inbred hounds, and partly because, especially in the matter of paternal inheritance, it presented irregularities, which even raised a suspicion of the goodness of the record‡. The greyhound naturally occurred to us as a dog of old standing bred for a purpose—speed—which was not closely and obviously associated with its coat-colour. We were, however, warned that breeders for coursing did fancy certain colours, and we found that the record as presented by the greyhound stud-books was very incomplete, i.e. a very small proportion of the members of any litter were ever recorded in these volumes. Hence, if selection for record took place largely by colour, we might be misled by the greyhound stud-book in a manner impossible in the case of the stud-book for thoroughbred race-horses. An examination of other dog records left on our minds the same doubt as to possible colour-selection in other cases, and thus, although the inheritance of coat-colour in dogs had been proposed for treatment at the same time as the race-horses were dealt with in 1899§, we had felt bound to leave it untouched. Meanwhile Mr Howard Collins of Edgebaston had also been occupied with the same problem, and troubled with the same doubt. He surmounted the difficulty, however, by the issue to greyhound breeders of a very large number of schedules in which details of colour of sire, dam, and the *whole* of the resulting litter were to be entered. In

* We have here in another form the great advantage, amid many disadvantages, of anthropometry as compared with craniometry.

† *R. S. Proc.* Vol. 61, p. 403.

‡ Pearson: "On the Law of Reversion." *R. S. Proc.* Vol. 66, p. 159.

§ Pearson and Bramley-Moore: *Phil. Trans.* Vol. 195, A, pp. 79—150.

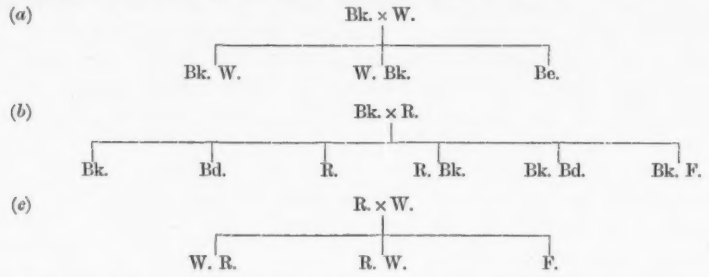
response to his request a large number of these schedules were duly filled in. All this material he placed unreservedly at the disposal of Professor W. F. R. Weldon, who in his turn handed it over for classification and calculation to the biometric workers in University College, London. This splendid material, for which we cannot too heartily thank Mr Collins and Professor Weldon, was supplemented by additional data extracted from the volumes of the *Greyhound Stud-book**. Thus the four fundamental parental tables were drawn from Mr Collins' data; four other parental tables for purposes of comparison and control were based on the stud-books. All the eight fundamental grandparental tables were based on pedigrees compiled from the stud-books, for Mr Collins' data extended to one generation only. Of the nine fundamental sibling tables, three for siblings from the same litter are based on Mr Collins' data, three for siblings from different litters and three for siblings of the same litter on the stud-books. The extraction of pedigrees from the stud-books and the classification of all the data into tables is the work of A. Barrington†. In the calculation of the correlations, the whole of the 50 sets taken by the fourfold table method are due to A. Lee. The whole of the calculation of correlations by the mean square contingency method was undertaken by A. Lee and A. Barrington conjointly. The labour of classification and calculation has been the work of a good many months, and has been more strenuous than is, perhaps, apparent on the surface. Only the work of putting the numerical results into tabular form and drawing conclusions from them is due to the third joint author of this paper.

(2) *Nature of colour classifications used.* In the classification of the greyhound we find in the first place the following main colours: *Red* (R.), *Fawn* (F.), *White* (W.), *Brindle* (Bd.), *Blue* (Be.), *Black* (Bk.). Besides these main colours we have a series of doubtful intermediates such as *Red or Fawn* (R. or F.), *Fawn or Red* (F. or R.), and a wide range of mixtures or particoloured dogs. Such are *Red-White* and *White-Red* (R. W. and W. R.), mixtures of Red, Fawn and White, e.g. R. F., F. R., W. F., F. W., R. F. W., F. R. W., W. R. F., R. or F. W., W. F. or R., W. R. or F., and the mixed brindles chiefly W. Bd., or Bd. W., but also: F. Bd., Bd. F., R. Bd., Bd. R., R. Bd. W., Be. Bd., Be. Bd. W., W. Bd. Be. Lastly we have the *Mixed Blues* and *Mixed Blacks*, including the *Ticked* (Tk.), e.g. Bk. W., W. Bk., Bk. Tk., Bk. W. Tk., W. Bk. Tk., W. Tk., Be. Tk., Be. F., Be. W., W. Be. In all we have found nearly forty different colour classes. Some of these of course are very similar, others perhaps not so definite as might be desirable; but the bulk of the cases fall into fairly well-defined groups, and the isolated units while they are recorded for future use in our fundamental tables have been embraced in wider groupings in the more manageable tables from which our numerical results are drawn.

* At present twenty volumes have appeared. The Editor is Mr W. F. Lamonby and it is published at the "Field" Newspaper Office.

† Actually she prepared 25 out of the 26 fundamental tables; the remaining table was originally prepared by F. E. Lutz, but it was revised and modified when the other series were extracted.

According to some authorities black and red are the original greyhound colours; white is said not to be found in any "natural breed of dogs." Black, red and white are often looked upon, however, as the three primitive "colours" by breeders. A mixture of these colours may then lead to a blend as in "fawn" and "blue," to particolour in large patches, to ticking in small spots or to stripes. According to Stonehenge we have the following pedigrees:




We are not convinced that such results pay sufficient attention to ancestry beyond the parents. Bd. × Bd. breeds as large a proportion true to parents as R. × R. or Bk. × Bk. Bk. × Bk. can produce R. and also F. The accompanying tables give the distribution of parents in the case of 2384 dogs and 2200 bitches. Here, to keep the tables within manageable limits, white has not been treated as a separate group except in the case of pure whites. Thus, of the red sires between $\frac{1}{3}$ and $\frac{1}{4}$ are red and white; of the brindle sires between $\frac{1}{2}$ and $\frac{1}{3}$ are brindle and white; of the fawn sires more than $\frac{1}{2}$ are fawn and white; of the mixed black sires $\frac{6}{7}$ are black and white and about $\frac{1}{7}$ blue; the remaining $\frac{1}{7}$ being chiefly blue and white, with a sprinkling of ticked and other rather nondescript dogs. Red shades off into fawn so that quite a large class of sires between $\frac{1}{6}$ to $\frac{1}{7}$ of the reds are described as red or fawn. Besides these we find a few isolated units classed as red and fawn, or red, fawn and white. As the tables stand, pure black contains dogs without mixture of red, fawn, brindle or white; fawn contains fawn, white and fawn; red contains red, red-fawn, red or fawn, and these with white. Brindle contains brindle, brindle-white with a few isolated units of brindle-reds and brindle-fawns. The blue-brindle and brindle-blacks are included in the mixed blacks. For more detailed classifications the reader must refer to the complete tables in the Appendix of this memoir. Now a reference to the above tables will show that melanism may appear in R. × R. crosses as well as in F. × F. crosses; that Bd. × Bd. may produce pure white or pure black dogs; that Bk. × R. may give white dogs; and that pure black dogs may produce pure white, red or fawn dogs. To use Mendelian language, the whole race of greyhounds appears to be in a heterozygous condition, and such pedigrees as those we have quoted from Stonehenge appear to have little valency when large numbers are studied.

(3) *White Dogs.* One great defect in our data is made manifest by an examination of Tables I and II; although we have there the parents of 4584 dogs

## TABLE I.

*Offspring Dogs.*

Sires.

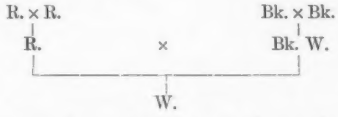
| Dams. | | | Red | Brindle | White | Fawn | Pure Black | Mixed Black | Totals |
|---|---|---|---|---|---|---|---|---|---|
| Red | Red ... ... | 37 | 10 | — | 52 | 19 | 17 | 135 |
| | Brindle ... | 4 | 40 | — | — | 7 | 7 | 58 |
| | White ... | 1 | — | 3 | — | — | 2 | 6 |
| | Fawn ... | 4 | 6 | — | 22 | 14 | 12 | 58 |
| | Pure Black... | 1 | 2 | — | — | 31 | 33 | 67 |
| | Mixed Black | 1 | 3 | — | — | 19 | 43 | 66 |
| Totals | — | 48 | 61 | 3 | 74 | 90 | 114 | 390 |
| Brindle | Red ... ... | 19 | 5 | — | 13 | — | 8 | 45 |
| | Brindle ... | 51 | 81 | 3 | 31 | 15 | 25 | 206 |
| | White ... | 2 | 1 | — | 1 | — | — | 4 |
| | Fawn ... | 16 | 8 | 1 | 20 | 1 | 10 | 56 |
| | Pure Black... | — | — | — | — | 28 | 23 | 51 |
| | Mixed Black | 1 | 1 | — | 2 | 5 | 53 | 62 |
| Totals | — | 89 | 96 | 4 | 67 | 49 | 119 | 424 |
| White | Red ... ... | — | — | — | 1 | — | — | 1 |
| | Brindle ... | — | — | — | 3 | 2 | 5 | 10 |
| | White ... | — | — | — | 2 | — | 1 | 3 |
| | Fawn ... | — | — | — | 5 | — | 2 | 7 |
| | Pure Black... | — | — | — | — | — | 3 | 3 |
| | Mixed Black | — | — | — | 2 | 5 | 10 | 17 |
| Totals | — | — | — | — | 13 | 7 | 21 | 41 |
| Fawn | Red ... ... | 16 | 10 | — | 14 | 13 | 5 | 58 |
| | Brindle ... | — | 39 | — | — | 7 | 10 | 56 |
| | White ... | 1 | 2 | 1 | — | 1 | — | 5 |
| | Fawn ... | 17 | 26 | 1 | 14 | 20 | 35 | 113 |
| | Pure Black... | — | 2 | — | — | 26 | 29 | 57 |
| | Mixed Black | 3 | 5 | — | 10 | 7 | 88 | 113 |
| Totals | — | 37 | 84 | 2 | 38 | 74 | 167 | 402 |
| Pure Black | Red ... ... | 15 | 8 | — | 5 | 9 | 5 | 42 |
| | Brindle ... | 8 | 33 | — | 7 | 10 | 12 | 70 |
| | White ... | — | — | — | — | — | 2 | 2 |
| | Fawn ... | 4 | 3 | — | 15 | 7 | 3 | 32 |
| | Pure Black... | 49 | 41 | — | 22 | 90 | 54 | 256 |
| | Mixed Black | 8 | 16 | — | 20 | 27 | 48 | 119 |
| Totals | — | 84 | 101 | — | 69 | 143 | 124 | 521 |
| Mixed Black | Red ... ... | 23 | 2 | — | 11 | 4 | 5 | 45 |
| | Brindle ... | 17 | 30 | — | 9 | 1 | 9 | 66 |
| | White ... | 3 | — | — | 7 | 1 | 3 | 14 |
| | Fawn ... | 7 | 18 | — | 44 | 9 | 10 | 88 |
| | Pure Black... | 16 | 14 | — | 13 | 25 | 38 | 106 |
| | Mixed Black | 28 | 58 | — | 53 | 33 | 115 | 287 |
| Totals | — | 94 | 122 | — | 137 | 73 | 180 | 606 |
| Grand Totals | — | 352 | 464 | 9 | 398 | 436 | 725 | 2384 |

TABLE II.

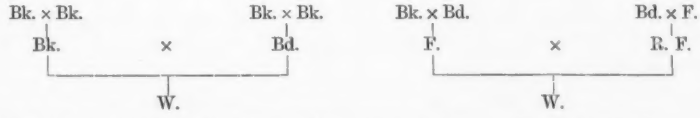
*Offspring Bitches.*

| Dams. | | Sires. Red | Brindle | White | Fawn | Pure Black | Mixed Black | Totals |
|---|---|---|---|---|---|---|---|---|
| Red | Red ... ... | 43 | 10 | — | 52 | 18 | 15 | 138 |
| | Brindle ... | 2 | 55 | — | — | 9 | 10 | 76 |
| | White ... | — | — | 3 | — | 1 | 1 | 5 |
| | Fawn ... | 9 | 8 | — | 19 | 11 | 15 | 62 |
| | Pure Black ... | — | 1 | — | — | 29 | 29 | 59 |
| | Mixed Black | — | 1 | — | — | 18 | 39 | 58 |
| Totals | — | 54 | 75 | 3 | 71 | 86 | 109 | 398 |
| Brindle | Red ... ... | 22 | 9 | — | 4 | — | 5 | 40 |
| | Brindle ... | 36 | 76 | 2 | 22 | 9 | 23 | 168 |
| | White ... | 1 | 2 | — | 1 | — | 2 | 6 |
| | Fawn ... | 8 | 5 | 1 | 25 | — | 9 | 48 |
| | Pure Black ... | 5 | — | — | — | 26 | 16 | 47 |
| | Mixed Black | 1 | — | — | 2 | 3 | 60 | 66 |
| Totals | — | 73 | 92 | 3 | 54 | 38 | 115 | 375 |
| White | Red ... ... | — | — | — | 2 | — | — | 2 |
| | Brindle ... | — | — | — | — | 1 | 4 | 5 |
| | White ... | — | — | — | 3 | — | 2 | 5 |
| | Fawn ... | — | — | — | 10 | — | — | 10 |
| | Pure Black ... | — | — | — | — | — | — | — |
| | Mixed Black | — | 1 | — | 2 | 2 | 12 | 17 |
| Totals | — | — | 1 | — | 17 | 3 | 18 | 39 |
| Fawn | Red ... ... | 7 | 12 | — | 13 | 9 | 4 | 45 |
| | Brindle ... | — | 30 | — | — | 6 | 11 | 47 |
| | White ... | — | 1 | — | 1 | 2 | — | 4 |
| | Fawn ... | 17 | 21 | 4 | 17 | 14 | 20 | 93 |
| | Pure Black ... | — | 2 | — | — | 27 | 23 | 52 |
| | Mixed Black | 1 | 6 | — | 7 | 13 | 70 | 97 |
| Totals | — | 25 | 72 | 4 | 38 | 71 | 128 | 338 |
| Pure Black | Red ... ... | 22 | 4 | — | 4 | 4 | 4 | 38 |
| | Brindle ... | 4 | 29 | — | 7 | 9 | 10 | 59 |
| | White ... | 1 | — | — | — | — | — | 1 |
| | Fawn ... | 10 | 7 | — | 23 | 4 | 5 | 49 |
| | Pure Black ... | 27 | 27 | — | 26 | 89 | 74 | 243 |
| | Mixed Black | 8 | 16 | — | 7 | 20 | 43 | 94 |
| Totals | — | 72 | 83 | — | 67 | 126 | 136 | 484 |
| Mixed Black | Red ... ... | 16 | 6 | — | 7 | 3 | 2 | 34 |
| | Brindle ... | 17 | 35 | — | 11 | 7 | 12 | 82 |
| | White ... | 2 | 1 | — | 3 | — | 2 | 8 |
| | Fawn ... | 6 | 13 | — | 43 | 8 | 3 | 73 |
| | Pure Black ... | 18 | 16 | — | 11 | 26 | 23 | 94 |
| | Mixed Black | 27 | 43 | — | 58 | 29 | 118 | 275 |
| Totals | — | 86 | 114 | — | 133 | 73 | 160 | 566 |
| Grand Totals | — | 310 | 437 | 10 | 380 | 397 | 666 | 2200 |

and elsewhere the parents of at least 4000 others, in no case have we the cross W. × W. This is undoubtedly an important cross and we endeavoured to obtain data on this point by seeking out the pedigrees of all the white dogs whose names were known to us. The paucity of material is due to the fact that very rarely one of a litter is pure white, and we have no evidence of any attempt to breed persistently from W. × W.* Upwards of 50 pedigrees of 'white' dogs going back to their 16 great-great-grandparents, and in some cases their great-great-great-grandparents were drawn up with the colours added in all cases where we could ascertain them. But not very definite information could be extracted from these pedigrees. There were six cases only of a W. dog with one parent W., three white dams and three white sires. Of these six cases of W. from parent W. we had no case of the parents of the W. parent being recorded as white. Indeed, no case of a W. grandparent at all. One or other of the grandparents was usually particoloured white. There were 16 cases in which a white dog was recorded from parents *both* of whom were white particolour. In all these cases there was white particolour in the grandparents in one or more cases, but quite frequently neither parent of a particoloured parent had any white; for example, R. × Bd. frequently gave white particolour. In only one recorded case was there a W. grandparent in this series. Where the grandparents of the W. dog through a particoloured white parent were R. × Bd. we found the white particolour reappeared in the parents of one or other or both of the R. and Bd. grandparents. There were 16 cases of one particolour white parent to the W. dog. In all these cases except one, there was more or less particolour white in the grandparents. In this one case we have:




But at least three of the great-grandparents, partly on the red and partly on the black side, were white particolour. There were 19 cases of white dogs with no white recorded at all in their parents, but here again the particoloured white appeared almost always in the grandparents. Of the two exceptions the pedigrees are;




But in both cases the particolour white occurs in the great-grandparents.

Of the 18 W. dogs with no recorded white in the parentage, four were from Bk. × R. crosses, one from a Bk. × Bk. cross, and six from Bd. × Bk. crosses.

* Mr W. F. Lamonby informs us that no breeder has made a speciality of a pure white strain; and considers that the attempt to create it would fail as the colours of former generations would crop up. This shows at any rate that leading breeders' opinion does not believe in white breeding true.

Further, four were from R. × F. crosses, and the remaining five introduced Be., Bk., Bd. and F. crosses of a miscellaneous character.

It is obvious from these results that the breeding out of white would be at least a difficult task, and that when white has substantially disappeared for a couple of generations, it may suddenly reappear in full force. If it be suggested that Bk. in the nomenclature would not exclude a white toe, nor W. a small black spot, then the reply must necessarily be that no theory of heredity can be of service for the purposes of evolution which would make one class of a white dog with a black toe and a black dog with a few white hairs on the throat, and professes only to predict when such a class as a whole will occur. The protective value of the coat-colour in the two cases would be wholly and entirely different, and we should have to seek further for those features of the pedigree with which the differentiation could be associated.

(4) *Colour Scales and Reduction Methods.* When we first started work on the greyhounds, the method of contingency had not yet been developed, and accordingly we made tables for the inheritance of melanism and of red pigment and proceeded to find the correlations by the fourfold division process*. In our classification we must admit having been influenced by the statement of breeders that brindle is the result of the crossing of red with black. A glance at our Tables I and II will show, however, that we cannot look upon red and black as pure forms giving a heterozygous brindle. We have in percentages based on 332

R. × Bk.

| R. | Bd. | W. | F. | P. Bk. | M. Bk. |
|---|---|---|---|---|---|
| 22 °/₀ | 8 °/₀ | 1 °/₀ | 12 °/₀ | 41 °/₀ | 16 °/₀ |

cases: a result which is capable of interpretation when we pay attention to ancestry (or, again, on the basis of a mixture of alternative inheritance and reversion), but is scarcely reducible to any simple Mendelian proportions, still less is it compatible with R. × Bk. = Bd.

The fact that R. × R. or R. × F. very rarely gives black of any kind (although F. × F. can give black), while Bd. × Bd. in the rarest cases gives Bk. of any kind, seems to denote more red than black in ordinary brindle and a closer relation of brindle to red than of fawn to red, although F. × F. in the bulk gives equal amounts of red and fawn. Accordingly we grouped our classes for red and black pigments as follows:

| *Red Pigment* | *Black Pigment* |
|---|---|
| (*a*) Red. | (*a'*) Pure Black. |
| (*b*) Brindle. | (*b'*) Mixed Black. |
| (*c*) Fawn. | (*c'*) Brindle. |
| (*d*) No Red. | (*d'*) Fawn. |
| | (*e'*) No Black. |

* *Phil. Trans.* Vol. 195, A, pp. 1—47.

($d$) contained all dogs with white or black, but no red or fawn of any kind. ($e'$) contained all red or white dogs or the mixture of these colours with fawn. We are now not at all certain that ($d'$) does not really contain more of black than ($c'$). We worked out afresh a certain number of tables in which ($d'$) was placed before ($c'$) but without real modification of result. The fourfold division of the red pigment inheritance table was made between ($b$) and ($c$), and of the black pigment table between ($c'$) and ($d'$) for the first set of cases, and after ($b'$) when ($d'$) was placed above ($c'$). We shall cite these methods as *Red A*, *Black B* and *Black C*, respectively. In contingency we took a 36-fold table as our standard, choosing the groupings R., Bd., W., F., P. Bk. and M. Bk. used as in Tables I and II. We shall speak of this method as *Contingency D*. In order to compare the fourfold method with contingency methods, 16-fold tables and 25-fold tables were worked out to compare with the fourfold tables adopted for the inheritance of red and black pigment respectively. These we shall refer to as *Contingency E*, and *Contingency F*. Further, in order to familiarise ourselves thoroughly with the scope and limitations of the new method of contingency, beside the investigations by mean square contingency adopted in D, E, F, we ($a$) determined a number of results by mean contingency*; and ($b$) worked out the mean square contingency in a few cases by 144-fold and 400-fold tables. The object of the latter was to test on a large scale the exaggerating effect of isolated units. The amount of arithmetical calculation involved in this investigation is thus not at all represented in the pages of the present memoir, but we believe it has been of advantage in enabling us to form just appreciations of the scope of the new method of contingency. In future it is likely that all our work on colour inheritance will be done by the use of method D, i.e. the application of mean squared contingency to groups sufficiently large not to be sensibly influenced by unit difficulties. Even with our 36-fold table the smallness of the white entries is to some extent a difficulty, but the Contingency F method shows us that the separation of the small unit groups of white has not seriously modified our results. The results deduced by Contingency D method are singularly uniform and steady as compared with those of the fourfold-table methods, and we believe if it be adopted generally for such pigmentation problems, it will not only free us from any question of pigmentation scale, but afford a good result on a not excessive expenditure of calculating energy. At the same time we can hardly over-emphasise the need for caution when isolated units are scattered over a table divided into a very large number of small classes†. As illustration of this we cite the following results for the correlation between siblings—dog and bitch—born in different litters of the same parents.

It will be seen that while the contingency result only increases from ·49 to ·51 when we pass from 16 to 36 groups, agreeing well with fourfold table results, we spring up to ·76 as we increase to 400 groups. In fact, the personal

* *Draper's Research Memoirs I.* "Mathematical Contributions to the Theory of Evolution: XIII. On the Mathematical Theory of Contingency," p. 31 (Dulau and Co., Soho Square, London).

† Memoir on contingency, *loc. cit.* pp. 16 and 35.

equation of any breeder who may call his dogs 'red-fawn' when the majority of breeders would call them 'red' is sufficient to very seriously alter the results when only 2000 dogs are dealt with. Accordingly, our choice of 16 to 36-fold classifications is based on the experience that these give results substantially in agreement with totally different methods, and we take as our standard process the mean square contingency method referred to above as D.

TABLE III.

*Correlation of Brothers and Sisters from Different Litters.*

| | |
|---|---|
| Mean of fourfold Tables (A and B) ... ... | ·521 |
| 16-fold Contingency Table E ... ... ... | ·488 |
| 25-fold Contingency Table F ... ... ... | ·502 |
| 36-fold Contingency Table D ... ... ... | ·509 |
| 144-fold Contingency Table ... ... ... | ·640 |
| 400-fold Contingency Table ... ... ... | ·760 |

Lastly, in case the reader should enquire why we dealt with red pigmentation and black pigmentation and have not considered the inheritance of white, we must remark that while many of the breeders filling in Mr Howard Collins' papers have noted a white ear or small white patches, etc. on black dogs*, we believe possibly the majority, it is not certain that absolutely all have done this; and we are quite sure that insignificant white patches are not noted in the stud-books. Accordingly it seemed best to confine our attention solely to the inheritance of black and red pigment. At the same time we make no statement as to our belief whether or no these pigments are qualitatively different; we consider that the contingency method enables us to fairly escape any such decision. No satisfactory treatment of the nature of pigment in hair has so far come to our notice.

(5) *On Direct Inheritance. Parental Correlations.* We place here our results for the data extracted from Mr Howard Collins' schedules and from the stud-books in the case of the four parental correlations worked out by method *Contingency D.*

TABLE IV.

| | Unselected Offspring | | Offspring Selected for Record | | |
|---|---|---|---|---|---|
| | Number | Correlation | Number | Correlation | |
| | | | | Raw | Corrected |
| Sire and Dog ... | 2392 | ·512 | 963 | ·474 | ·542 |
| Sire and Bitch ... | 2231 | ·579 | 913 | ·404 | ·462 |
| Dam and Dog ... | 2419 | ·505 | 963 | ·485 | ·554 |
| Dam and Bitch ... | 2237 | ·532 | 913 | ·499 | ·572 |
| Mean ... | — | ·532 | — | ·466 | ·532 |

* Such dogs have been classed as 'mixed black.'

The mean of 12 fourfold tables, three for each parental table, by methods of division A, B, C above, was ·526. We think we may therefore safely say that the 36-fold contingency table leads to results in quite good agreement with the mean of the older process of dealing with quantities not quantitatively measurable. Nor are the individual results which by the fourfold method are: Sire and Dog, ·538; Sire and Bitch, ·615; Dam and Dog, ·467; Dam and Bitch, ·482, widely different. Nor do we find any sensible difference if we consider the inheritance of 'red pigment' and of 'black pigment,' the mean parental coefficients being ·520 and ·529 for the two cases respectively. Lastly, the mean parental correlation from four 25-fold and four 16-fold contingency tables was ·492, somewhat less than the value as given by the fourfold method or the 36-fold contingency method, which, as we have seen, are in good agreement. We believe that ·53 represents extremely well the average parental relation in pigment in the case of greyhounds.

We compare this in the following table with previous pigmentation results:

TABLE V.

*Direct Inheritance of Pigmentation.*

| | Man Eye-Colour | Horse Coat-Colour | Dog, Basset Hound Coat-Colour | Dog, Greyhound Coat-Colour | Mean |
|---|---|---|---|---|---|
| Father and Son ... | ·550 | ·491 | ?* | ·512 | ·518 |
| Father and Daughter | ·437 | ·542 | ? | ·579 | ·519 |
| Mother and Son ... | ·482 | ·486 | ·508 | ·505 | ·495 |
| Mother and Daughter | ·510 | ·567 | ·544 | ·532 | ·538 |
| Mean ... | ·495 | ·522 | ·526 | ·532 | ·518 |

This table seems to indicate that there is no evidence at present to show that pigmentation inheritance differs in intensity in man, horse or dog, nor is there evidence to indicate any persistent preponderance of one sex. We should notice, however, that in all four cases the daughter is more like the mother than the son is. On the other hand the daughter is more like the father than the son is in horse and dog, the sex similarity being only preserved in the case of eye-colour in man. We may safely say that the inheritance of pigmentation cannot differ widely from ·50 for all our series.

If we turn to parental inheritance in the case of dogs selected for record we see that the correlation has been reduced, a result which is the general rule whenever selection takes place. The reducing factor is ·875. Being completely ignorant of the relative standard deviations of the material under consideration, we can hardly reach a more scientific measure of the selection that takes place in record than this reducing factor. But its value is sufficient to show us that our original hesitation to use the greyhound stud-book was justifiable; the correlation

* See *R. S. Proc.* Vol. 66, p. 159 ftn. Increased information as to inheritance in dogs confirms the view that the sires given in the Basset Stud-book are unreliable.

of parent and offspring is sensibly reduced by selection in recording. Mr Howard Collins' data enable us, however, to roughly allow for this selection; the corrected values are indicated in the last column of Table IV, and we shall proceed to use a like correction in the following paragraph.

(6) *On Direct Inheritance. Grandparental Correlations.* We can here unfortunately only deal with the data from the stud-books. The greyhounds, whose offsprings were recorded for Mr Howard Collins, appear to be in great bulk, if not entirely, well-known hounds whose names are in the stud-books. The selection arises from only one or two individuals in each litter being recorded in the stud-books. This, as we have seen, weakens the correlation; possibly it arises because the offspring of more fashionable colours only are recorded in the case of a litter, the parents of which may be of less fashionable colours. If we consider grandchildren of stud-book parents, then there has clearly been a selection out of the litters of this generation, not only of some members of each litter, but of whole litters, because certain parents have been omitted from record altogether, as the rejected members of the litters of the first generation. Now the problem thus stated becomes undoubtedly a complex one, as the reduction for influence of selection on correlation, if the selection extends over several generations, is by no means easy to determine. But it seems not unreasonable to suppose that the total distribution of colour in the sporting greyhound, although probably subject to secular change, is not changing very rapidly. In other words, the effect of selection for *breeding* is to maintain a nearly constant colour distribution for a few generations. If this be so, the chief effect of selection in record is due to the weakening of the correlation by selection of offspring and not to the selection of the breeding parents or grandparents. Accordingly it seems to us that all we can do is to divide the grandparental correlations we find from stud-book pedigrees by the factor ·875, and treat these as the best approximations available to the grandparental correlations. We have then the following results.

TABLE VI. *Grandparental Correlations.*

Mean Square Contingency 36-fold tables.

| Grandparent and Offspring | Number | Raw Value* | Probable Reduced Value |
|---|---|---|---|
| Paternal Grandsire and Dog ... | 952 | ·275 | ·314 |
| Paternal Grandsire and Bitch ... | 893 | ·229 | ·261 |
| Maternal Grandsire and Dog ... | 939 | ·264 | ·301 |
| Maternal Grandsire and Bitch ... | 888 | ·336 | ·384 |
| Paternal Grandam and Dog ... | 947 | ·322 | ·368 |
| Paternal Grandam and Bitch ... | 900 | ·272 | ·311 |
| Maternal Grandam and Dog ... | 911 | ·291 | ·332 |
| Maternal Grandam and Bitch ... | 863 | ·338 | ·386 |
| Mean ... ... | — | ·291 | ·332 |

* The grandparental tables treated by the fourfold method gave—owing to some extent to paucity of number—rather irregular results. The mean of 16 fourfold tables Red A and Black B was ·213, and of sixteen 16-fold and 25-fold contingency E and F tables ·247, both less than the 36-fold tables.

It would thus appear that the grandparental correlation cannot be very different from the mean value $\frac{1}{3}$.

If we compare the results now obtained with earlier pigmentation series we have the following table:

TABLE VII.

*Grandparental Relationship.*

| Grandparent and Offspring | Man Eye-Colour | Horse Coat-Colour | Greyhound Coat-Colour | Mean |
|---|---|---|---|---|
| Paternal Grandfather and Son ... | ·421 | ·324 | ·314 | ·353 |
| Paternal Grandfather and Daughter... | ·380 | ·361 | ·261 | ·334 |
| Maternal Grandfather and Son ... | ·372 | ·359 | ·301 | ·344 |
| Maternal Grandfather and Daughter... | ·297 | ·312 | ·384 | ·331 |
| Paternal Grandmother and Son ... | ·272 | ·309 | ·368 | ·316 |
| Paternal Grandmother and Daughter | ·221 | ·204 | ·311 | ·245 |
| Maternal Grandmother and Son ... | ·252 | ·261 | ·332 | ·282 |
| Maternal Grandmother and Daughter | ·318 | ·235* | ·386 | ·313 |
| Mean ... ... | ·317 | ·296 | ·332 | ·315 |

We conclude from this that as in the case of parents, so in the case of grandparents, there is no substantial difference in pigmentation inheritance between man, horse and greyhound. We may reasonably hold that a geometrical series:

$$\frac{1}{2},\ \frac{1}{2}\times\frac{2}{3},\ \frac{1}{2}\times\left(\frac{2}{3}\right)^2,\ \frac{1}{2}\times\left(\frac{2}{3}\right)^3,\ \ldots$$

will express the decreasing correlations between offspring and ancestry as closely for the greyhound as it does for man and horse†.

The evidence in favour of a change of sex weakening the intensity of hereditary influence is of a rather doubtful kind. It has been shown to hold for eye-colour in man by Pearson‡, both in the case of direct and collateral heredity, and by Lutz§ for further data in the case of direct inheritance. It does not appear to be markedly true for coat-colour in horses. For greyhounds it is not absolutely true, although the differences are of the probable-error order in the case of the unselected parental relations. Here the sire, as in the case of the horse, has a more marked influence on the coat-colour of the daughter than on that of the son, while the dam for man, for horse and for both cases of dogs is more influential in the case of the daughter than in that of the son. In the grandparental series it does however appear to be true; thus we find:

* Erroneously given as ·2392 instead of ·2351 owing to a slip in the value used for log $k$ in finding the equation for $r$ in *Biometrika*, Vol. II. p. 231. The value for $k$ is correct, the equation for $r$ slightly incorrect.

† See "The Law of Ancestral Heredity," *Biometrika*, Vol. II. pp. 211 *et seq.*

‡ *Phil. Trans.* Vol. 195, A, pp. 114—117.

§ *Biometrika*, Vol. II. pp. 237—240.

Grandparental correlations with regard to change of sex:

| | |
|---|---|
| Mean value no change of sex: | ·350. |
| Mean value one change of sex: | ·336. |
| Mean value two changes of sex: | ·306. |

It is further true for the selection in record values of the parental correlations*. Thus we are inclined to think that there really exists a weakening of inheritance with change of sex in the case of the greyhound, but that it is so small that it is liable to be screened by the probable errors of the results.

On the whole, for direct inheritance of pigmentation, the greyhound falls quite well into the system formerly found for man and horse.

(7) *Collateral Resemblance in the First Degree.* From the material available on Mr Howard Collins' schedules we could only obtain the degree of resemblance between siblings of the same litter. There was no possibility of getting siblings from different litters except by appeal to the stud-books with their selection for record. Since selection for record depends on the personal equation of the breeder, and the points he selects may to some extent involve coat-colour, the tendency accordingly ought to be to emphasise rather than reduce the fraternal correlation. We find, however (Table VIII), that when we compare the unselected record of the schedules for the *same* litter with the selected record of the stud-books for *different* litters that the values are much reduced, i.e. from ·676 to ·529 on the average. Our first idea was that this great reduction must be due to the fact that we are in one case considering siblings from the *same* and in the other case from *different* litters, or that there must be a sensible difference in the degree of resemblance in the two cases. This was opposed to our experience in the case of Basset Hounds†. To confirm the supposition in the case of the greyhound, we worked out from the stud-books all three sibling relationships for the case of siblings from the *same* litter. To our great surprise the result was only slightly in excess of the result obtained for siblings from different litters. In other words, for the greyhound if the *same* material was used in both cases, the conclusion reached for the Basset Hound seemed to apply, i.e. there was no very marked difference in fraternal resemblance when the siblings were and were not from the same litter. We were thus left in considerable doubt as to what interpretation could be put on the fact that fraternal correlation between members of the same litter when found from the schedules and from the stud-books was so markedly different. It seemed difficult to believe that it could be due to selection for record, because it appeared to us that this ought, as far as it influenced colour, to tend to increase the correlation. On examining our totals for the two cases we noted one point which might conceivably throw light on the matter. In the schedules we had 651 pairs of parents, giving rise to 7484 pairs

* The means for unselected and corrected selected values of parental correlation give ·539 for no change of sex and ·524 for one change of sex, a slight difference.

† *Royal Soc. Proc.* Vol. 66, p. 158.

of brothers or about 11·5 pairs to each pair of parents; brothers of the same litter from the stud-book were given by 532 pairs of parents and provided 2144 fraternal pairs, or about four pairs to each pair of parents; lastly, brothers of different litters from the stud-book were provided by 258 pairs of parents, and these gave 1044 pairs of brethren, or again about four to each pair of parents. Could it be that this difference in the number of brethren to each pair of parents was the source of the large drop in correlation as we passed from schedules to stud-book? This point was then taken up and investigated*. The members of a litter were given numbers, 1, 2, 3, ... and these were put on tickets and pairs of these tickets drawn at random. In this way 2086 pairs of brothers were obtained, no brother being used with more than one other brother. The table thus obtained is given as Table MMMM in the Appendix. The correlation obtained by the 36-fold table is ·6697, while for 7484 brothers using *every* brother with every other brother it is ·6607. The difference is in fact insensible, but the larger correlation is in the series of *non-repeated* brothers. We conclude therefore that the difference between the fraternal correlation for brethren from the same litter as taken from the schedules and from the stud-book is not due to any purely arithmetical effect of taking many pairs from large litters. The only other explanation we can give, but we see no means at present of testing its truth, lies in the view that the colours of the litter were taken at a much earlier stage for Mr Howard Collins' schedules, than for the stud-book. In the latter cases dogs are often not entered for a year or two. It is possible therefore that the litter as a whole is more alike

TABLE VIII.

*Collateral Heredity. Resemblance of Siblings.*

| Nature of Sibling Pair | Unselected Record | | | | Selected Record | | | |
|---|---|---|---|---|---|---|---|---|
| | Same Litter, Repeated Brothers | | Same Litter, Non-repeated Brothers | | Same Litter | | Different Litters | |
| | No. | Correlation | No. | Correlation | No. | Correlation | No. | Correlation |
| Dog and Dog ... | 7484 | ·661 | 2086 | ·670 | 2144 | ·524 | 1044 | ·521 |
| Bitch and Bitch | 6542 | ·700 | — | — | 2002 | ·595 | 1010 | ·558 |
| Dog and Bitch | 7175 | ·669 | — | — | 2864 | ·558 | 1031 | ·509 |
| Mean ... | — | ·676 | — | ·670 | — | ·559 | — | ·529 |

* The whole problem is a difficult one, there are so many statistical pitfalls surrounding it. Theoretically it would seem that both for fraternal and homotypic correlations the increase in the number of brothers or of homotypes taken from each unit ought to alter the correlation, actually we cannot find much difference when the same material is worked out with many and with few members of each unit. See the "Homotyposis" memoir, *Phil. Trans.* Vol. 197, A, pp. 310—313; the memoir on "Mendel's Principles," *Phil. Trans.* Vol. 203, A, pp. 74—77 and the paper on "Telegony in Man," *R. S. Proc.* Vol. 60, p. 279.

in the puppy-stage than the siblings are at a later age, and accordingly this may account for the lessened resemblance of stud-book pairs of brethren. It may be possible later to test this, but at present we can only throw it out as a suggestion, we see no other way to account for the anomalous results of the Table.

The last column gives a result agreeing remarkably well with that for Basset Hounds from different litters, but the want of agreement between the first and last column is very striking. We can only ask: Is it due to record at too early a stage?

The above results for fraternal correlation were all found by Contingency D method, i.e. that of mean square contingency for a 36-fold table. For comparative purposes three fourfold division tables were worked out by method Red A and another three by method Black B. We obtained the results given below in Table IX.

TABLE IX.

*Mean Sibling Resemblance.*

| Method | Same Litter Schedules | Different Litter Stud-book |
|---|---|---|
| 36-fold Contingency D ... ... ... | ·676 | ·529 |
| Two fourfold Divisions A and B ... ... | ·680 | ·538 |
| 16-fold and 25-fold Contingency E and F... | ·640 | ·498 |

We see from this that a 36-fold contingency table gives results in sensible agreement with those to be found from the old fourfold division method, while in 16-fold and 25-fold tables the result is very slightly less, showing that the grouping is hardly fine enough. We now pass to the comparison with man and horse, the

TABLE X.

*Resemblance in Pigment of Siblings.*

| Nature of Sibling Pair | Man | | Horse | Dog, Coat-Colour | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Greyhound | | | Basset Hound | |
| | Eye-Colour | Hair-Colour | Coat-Colour | Same Litter | | Different Litters | Same Litter | Different Litters |
| | | | | Schedules | Stud-book | | | |
| Brother and Brother | ·517 | ·620 | ·623 | ·661 | ·524 | ·521 | ·508 | ·526 |
| Sister and Sister ... | ·446 | ·570 | ·693 | ·700 | ·595 | ·558 | | |
| Brother and Sister... | ·462 | ·550 | ·583 | ·669 | ·558 | ·509 | | |
| Mean ... | ·475 | ·580 | ·633 | ·676 | ·559 | ·529 | ·508 | ·526 |

data for which are given in the memoirs cited below*. The results are given in Table X. We see that we have here a very considerable range of values, that the Basset Hounds and the Stud-book Greyhounds agree well with the mean value for man†, but that the Thoroughbred Horses and Schedule Greyhounds exceed these values. The only common factor that we see to explain this difference lies possibly in the earlier age of record in the last two cases. The hair-colour changes with growth in the case of children‡, but there is probably greater uniformity in the hair-colour of siblings in the first year of life than at any later age—our records are for children in the bulk between 10 and 14 years old—and this is a stage hardly comparable with that of yearlings and puppies, as far as definiteness of hair-colour is concerned§.

It will be seen from these results that the suggestion made in *Biometrika*, Vol. II. p. 391, that the high value of the greyhound fraternal correlation is due to the action of individual prepotency on members of the same litter, is not confirmed. We consider that in the case of the dog we may safely say that there is no marked difference between the degree of resemblance of siblings of the same and of different litters. After considerable labour we found it impossible to collect enough data from the stud-books for horses to test the same point on twin and non-twin foals of the same parents. Both twins rarely survive to be recorded, and twin foals themselves are infrequent. The point can and will be dealt with on the basis of Darbishire's material for mice. So far, however, even if a co-uterine environment does increase the resemblance of brethren from the same litter in some species, it certainly does not appear to do so for all, and at any rate the high value of fraternal correlation in the case of the greyhound is not due to this source. It is peculiar to the nature of the record. We believe as in the case of the horse it may possibly be due to a mere temporary influence on the somatic characters of the embryonic co-environment. This disappears when the record of the colour is taken at a later stage. Should this view be the correct one the stud-book records would after all turn out to be of more value than the schedule records. We should then conclude that judged from pigmentation the inheritance in greyhounds is given by:

·466 for parental correlation, and ·529 for fraternal correlation (different litters).

These numbers would be in excellent agreement with the corresponding mean values ·460 and ·519 found for physical measurements in man‖.

* *Phil. Trans.* Vol. 195, A, pp. 93 and 106. *Biometrika*, Vol. III. pp. 154 *et seq.* The hair-colour returns have been taken from school children; these children give ·53 for eye-colour—a result close to Greyhound and Basset Hound values for *different* litters.

† The mean value in the case of man for 9 series of physical measurements in the adult is ·519 (*Biometrika*, Vol. II. p. 519) and for 12 series of head-measurements in children is ·513 (*Biometrika*, Vol. III. p. 140).

‡ The correlation is not nearly so great as some have supposed, but of this more on another occasion.

§ In cattle the like difficulty arises. Some are recorded as mere calves and the colour changes a good deal after losing the first coat. Thus a bull calf recorded as a 'fawn' may be ultimately a 'dark fawn' or 'red' bull.

‖ *Biometrika*, Vol. II. pp. 378 and 390.

It is possible that the difficulty here suggested, a temporary influence of embryonic co-environment, ought to be more fully regarded when records are taken of breeding experiments, especially in all cases of hair-colour where the 'adult' colour may not be sufficiently closely approximated to until after the loss of the first coat*.

Still we are not prepared to attribute all high fraternal correlations to such a source as too early record. We consider that there is really greater variation in fraternal than in parental resemblances. Some of it may be due to a permanent effect of co-environment, embryonic or not. The problem is one of considerable interest and yet of great difficulty, and we only hope that more light may yet be thrown on it from further reduction of records or direct breeding experiments.

(8) *General Conclusions.* Our reductions of the greyhound data indicate:

(i) That whether there be one or more pigments, no class of greyhound can be looked upon as purely dominant or purely recessive. The colours of the earlier ancestry crop up in the offspring of parents of definite colours. We do not see how Mendelian principles can be in any way applied to the greyhound. We publish, however, the whole of our tabulated data, and are quite ready to receive and work out reasonable suggestions for its statistical reduction on Mendelian lines.

(ii) That as far as ancestry is concerned the biometrical statistical method leads to parental and grandparental correlations sensibly identical with those which have already been found for pigmentation inheritance in man and horse. There can be no question therefore whether the knowledge of the ancestry is or is not important. It is equally important in all three cases, and no good prediction can neglect the high correlations of the ancestry beyond the parents.

(iii) That if we deal only with the stud-book records there is no difference of a marked character between siblings from the same and different litters, and the values of the fraternal correlation reached are in excellent agreement with those found for Basset Hounds and for pigmentation and physical measurements in the case of man. But if we deal with a colour-record made with the litters in a very early stage, we find the highest fraternal correlations yet reached. The nearest approach to them are the coat-colour correlations in the case of the horse, followed at some distance by Dr Warren's values for *Aphis* and *Daphnia*. It is probable that these high fraternal values with fairly uniform parental correlations are due to different sources, possibly to too early recording in the horse and dog, almost certainly to differentiated environment in the case of the insects. We submit, however, that while fraternal correlation 'clusters' between ·5 and ·6,

* The percentage returns given by Virchow, Pfitzner and others for darkening of the hair with age are fallacious because they are not dealing with the *same* material at different ages. They have neglected (i) the selection of the fitter—health we find to be correlated with hair colour—and (ii) the children in the primary schools (Virchow) are compared with a totally different group and *class* in the high schools. We are returning to this matter in another paper.

the nature of its variation and its relation to parental correlation are still very obscure.

(iv) That so far as work on the inheritance of pigmentation in the Biometric Laboratory at University College has yet gone, we find that for man, horse and dog in long series the results are in good agreement, and can be described by the statement that ancestral correlations diminish in a geometrical series and sensibly the same series. We hope shortly to publish two further long series of pigmentation inheritance statistics; should they give results in accordance with those already reached, no further reductions of this kind will be made by us, for we think the generality of the law will have been sufficiently demonstrated. In saying this we do not overlook the vast amount of material now being collected by Darbishire and others on inheritance of pigmentation in mice, but it is unfortunately not in a form to which it is easy to apply the mathematical processes required. The selection is so stringent, when two true breeding strains are crossed, that it is difficult to apply the complex equations for the influence of selection on correlation. What we should especially like to know would be: (*a*) after hybridisation, do or do not the offspring of the hybrids, if mated at random *inter se*, give a stable population? (*b*) If they do give a stable population, do the ancestral correlations diminish or not in a geometrical series? and (*c*) If they do, are their numerical values sensibly or not the same as those we have found for man, horse and dog? If these questions were answered in the affirmative, then it would be more possible to determine the relationship between so-called Mendelian Principles and the Ancestral Law. The latter seems to apply closely to any fairly stable population with random or nearly random mating, even in the matter of pigmentation. According to the Mendelian hypothesis developed by one of us, the offspring of the hybrids should, if mated at random, give a stable population, and this is likely to be true on many other hypotheses. What happens in such a population? According to the view of some Mendelians both factors of the original cross are, as far as some one character at least is concerned, in appearance, elements of such a population; this being so we ought to be able to see, once the stability of such a population of hybrid's offspring is established, much more clearly than at present the relation of the two views to each other. The differences between our man, horse and dog returns and Darbishire's mice returns seem to consist essentially in this: that in the three former or intra-racial results the intra-breeding between differently pigmented members has gone on for generations, while in the latter or inter-racial results there has been separation for generations. But if the offspring of hybrids mated at random give a 'stable' population, then we ought to be able to predict at least certain phenomena with regard to the result of crossing its constituents. What is now quite clear about the mice is that ancestry can be no more neglected in their case than in the cases of man, dog or horse.

## APPENDIX I.

### 36-*fold Contingency Tables.*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### TABLE $\alpha$.

Sire.

| Offspring ♂. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 204 | 171 | 75 | 35 | — | 57 | 542 |
| M. Bk. ... | 103 | 362 | 84 | 89 | — | 49 | 687 |
| Bd. ... | 39 | 64 | 226 | 54 | 3 | 80 | 466 |
| F. ... | 51 | 71 | 64 | 129 | 2 | 48 | 365 |
| W. ... | 1 | 6 | 2 | 1 | — | 3 | 13 |
| R. ... | 45 | 38 | 39 | 96 | — | 101 | 319 |
| Totals ... | 443 | 712 | 490 | 404 | 5 | 338 | 2392 |

TABLE $\beta$.

Sire.

| Offspring ♀. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 209 | 147 | 50 | 39 | — | 48 | 493 |
| M. Bk. ... | 94 | 344 | 69 | 78 | — | 42 | 627 |
| Bd. ... | 41 | 69 | 216 | 41 | 2 | 63 | 432 |
| F. ... | 38 | 53 | 53 | 146 | 5 | 58 | 353 |
| W. ... | 2 | 7 | 3 | 8 | 3 | 3 | 26 |
| R. ... | 32 | 29 | 41 | 83 | — | 115 | 300 |
| Totals ... | 416 | 649 | 432 | 395 | 10 | 329 | 2231 |

TABLE $\chi$.

Dam.

| Offspring ♂. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 259 | 98 | 53 | 59 | 5 | 66 | 540 |
| M. Bk. ... | 118 | 300 | 66 | 113 | 15 | 69 | 681 |
| Bd. ... | 70 | 69 | 207 | 57 | 8 | 58 | 469 |
| F. ... | 34 | 85 | 62 | 117 | 7 | 59 | 364 |
| W. ... | 2 | 14 | 4 | 5 | 3 | 5 | 33 |
| R. ... | 42 | 48 | 46 | 59 | 1 | 136 | 332 |
| Totals ... | 525 | 614 | 438 | 410 | 39 | 393 | 2419 |

TABLE $\delta$.

Dam.

| Offspring ♀. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 247 | 96 | 49 | 47 | — | 62 | 501 |
| M. Bk. ... | 95 | 280 | 62 | 100 | 14 | 62 | 613 |
| Bd. ... | 56 | 82 | 175 | 48 | 5 | 67 | 433 |
| F. ... | 51 | 82 | 50 | 96 | 10 | 62 | 351 |
| W. ... | 1 | 9 | 8 | 5 | 4 | 4 | 31 |
| R. ... | 39 | 34 | 41 | 44 | 2 | 148 | 308 |
| Totals ... | 489 | 583 | 385 | 340 | 35 | 405 | 2237 |

TABLE *aa*.

Sire.

| Offspring ♂. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 59 | 57 | 42 | 17 | 1 | 36 | 212 |
| M. Bk. ... | 23 | 64 | 40 | 27 | 2 | 22 | 178 |
| Bd. ... | 16 | 25 | 143 | 28 | — | 39 | 251 |
| F. ... | 11 | 24 | 24 | 34 | — | 44 | 137 |
| W. ... | — | 3 | 2 | 2 | — | 4 | 11 |
| R. ... | 18 | 10 | 35 | 36 | — | 75 | 174 |
| Totals ... | 127 | 183 | 286 | 144 | 3 | 220 | 963 |

TABLE $\beta\beta$.

Sire.

| Offspring ♀. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 44 | 54 | 48 | 18 | — | 47 | 211 |
| M. Bk. ... | 13 | 41 | 29 | 26 | 1 | 26 | 136 |
| Bd. ... | 24 | 31 | 127 | 32 | — | 34 | 248 |
| F. ... | 12 | 14 | 31 | 36 | — | 43 | 136 |
| W. ... | 1 | — | 7 | 3 | — | 5 | 16 |
| R. ... | 14 | 14 | 35 | 30 | — | 73 | 166 |
| Totals ... | 108 | 154 | 277 | 145 | 1 | 228 | 913 |

TABLE $\chi\chi$.

Dam.

| Offspring ♂. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 68 | 80 | 29 | 14 | — | 21 | 212 |
| M. Bk. ... | 44 | 76 | 17 | 20 | — | 21 | 178 |
| Bd. ... | 32 | 53 | 104 | 23 | — | 39 | 251 |
| F. ... | 10 | 29 | 25 | 45 | — | 28 | 137 |
| W. ... | — | 3 | 4 | 1 | 1 | 2 | 11 |
| R. ... | 27 | 24 | 32 | 25 | 1 | 65 | 174 |
| Totals ... | 181 | 265 | 211 | 128 | 2 | 176 | 963 |

TABLE $\delta\delta$.

Dam.

| Offspring ♀. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 85 | 68 | 23 | 9 | — | 26 | 211 |
| M. Bk. ... | 30 | 67 | 10 | 18 | 2 | 9 | 136 |
| Bd. ... | 29 | 53 | 100 | 25 | — | 41 | 248 |
| F. ... | 17 | 28 | 27 | 47 | — | 17 | 136 |
| W. ... | 2 | 4 | 2 | 5 | 1 | 2 | 16 |
| R. ... | 22 | 33 | 23 | 28 | — | 60 | 166 |
| Totals ... | 185 | 253 | 185 | 132 | 3 | 155 | 913 |

TABLE $\epsilon$.

Paternal Grandsire.

| Offspring ♂. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 76 | 30 | 45 | 1 | — | 58 | 210 |
| M. Bk. ... | 71 | 33 | 27 | 8 | — | 38 | 177 |
| Bd. ... | 73 | 45 | 65 | 8 | — | 58 | 249 |
| F. ... | 31 | 31 | 31 | 8 | — | 31 | 132 |
| W. ... | 3 | 3 | — | — | — | 5 | 11 |
| R. ... | 22 | 36 | 37 | 4 | — | 74 | 173 |
| Totals ... | 276 | 178 | 205 | 29 | — | 264 | 952 |

TABLE $\phi$.

Paternal Grandsire.

| Offspring ♀ | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 64 | 49 | 34 | 6 | — | 56 | 209 |
| M. Bk. ... | 43 | 22 | 24 | 7 | — | 40 | 136 |
| Bd. ... | 74 | 35 | 65 | 8 | — | 60 | 242 |
| F. ... | 36 | 26 | 14 | 7 | — | 44 | 127 |
| W. ... | 4 | 1 | 1 | 1 | — | 8 | 15 |
| R. ... | 24 | 38 | 36 | 4 | — | 62 | 164 |
| Totals ... | 245 | 171 | 174 | 33 | — | 270 | 893 |

TABLE $\gamma$.

Maternal Grandsire.

| Offspring ♂ | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 56 | 66 | 40 | 14 | — | 30 | 206 |
| M. Bk. ... | 35 | 58 | 34 | 14 | — | 28 | 169 |
| Bd. ... | 74 | 33 | 57 | 15 | 3 | 64 | 246 |
| F. ... | 33 | 20 | 30 | 20 | — | 31 | 134 |
| W. ... | 3 | 1 | 2 | 1 | — | 3 | 10 |
| R. ... | 36 | 29 | 37 | 17 | — | 55 | 174 |
| Totals ... | 237 | 207 | 200 | 81 | 3 | 211 | 939 |

TABLE $\theta$.

Maternal Grandsire.

| Offspring ♀ | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 65 | 64 | 29 | 9 | 2 | 36 | 205 |
| M. Bk. ... | 43 | 41 | 29 | 7 | — | 12 | 132 |
| Bd. ... | 61 | 33 | 67 | 23 | 1 | 54 | 239 |
| F. ... | 35 | 18 | 32 | 25 | — | 24 | 134 |
| W. ... | 4 | 3 | 3 | 3 | — | 2 | 15 |
| R. ... | 25 | 35 | 26 | 16 | — | 61 | 163 |
| Totals ... | 233 | 194 | 186 | 83 | 3 | 189 | 888 |

TABLE $\iota$

Paternal Grandam.

| Offspring ♂ | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 33 | 57 | 60 | 14 | — | 44 | 208 |
| M. Bk. ... | 22 | 47 | 54 | 20 | 3 | 27 | 173 |
| Bd. ... | 34 | 30 | 117 | 19 | — | 49 | 249 |
| F. ... | 20 | 25 | 24 | 21 | 7 | 39 | 136 |
| W. ... | 3 | 3 | 3 | — | — | 2 | 11 |
| R. ... | 25 | 27 | 46 | 11 | — | 61 | 170 |
| Totals ... | 137 | 189 | 304 | 85 | 10 | 222 | 947 |

TABLE F.

Paternal Grandam.

| Offspring ♀ | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 33 | 52 | 48 | 20 | 3 | 49 | 205 |
| M. Bk. ... | 18 | 35 | 36 | 13 | 1 | 29 | 132 |
| Bd. ... | 34 | 32 | 113 | 20 | — | 48 | 247 |
| F. ... | 23 | 23 | 37 | 18 | 2 | 32 | 135 |
| W. ... | 2 | 1 | 6 | 4 | — | 3 | 16 |
| R. ... | 31 | 26 | 33 | 13 | 2 | 60 | 165 |
| Totals ... | 141 | 169 | 273 | 88 | 8 | 221 | 900 |

TABLE K.

Maternal Grandam.

| Offspring ♂. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 58 | 53 | 25 | 21 | 6 | 32 | 195 |
| M. Bk. ... | 34 | 58 | 27 | 18 | — | 28 | 165 |
| Bd. ... | 49 | 46 | 68 | 37 | 2 | 39 | 241 |
| F. ... | 16 | 36 | 16 | 21 | — | 41 | 130 |
| W. ... | 1 | 1 | 4 | 2 | — | 2 | 10 |
| R. ... | 28 | 48 | 28 | 15 | 1 | 50 | 170 |
| Totals ... | 186 | 242 | 168 | 114 | 9 | 192 | 911 |

TABLE λ.

Maternal Grandam.

| Offspring ♀. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 57 | 70 | 17 | 17 | 5 | 32 | 198 |
| M. Bk. ... | 35 | 44 | 10 | 13 | 1 | 26 | 129 |
| Bd. ... | 54 | 47 | 54 | 37 | 1 | 43 | 236 |
| F. ... | 19 | 40 | 15 | 20 | 1 | 34 | 129 |
| W. ... | 3 | 4 | 4 | 2 | 2 | 1 | 16 |
| R. ... | 19 | 45 | 43 | 18 | — | 30 | 155 |
| Totals ... | 187 | 250 | 143 | 107 | 10 | 166 | 863 |

TABLE μ.

First Brother.

| Second Brother. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 954 | 340 | 187 | 154 | 3 | 136 | 1774 |
| M. Bk. ... | 340 | 1276 | 181 | 204 | 29 | 103 | 2133 |
| Bd. ... | 187 | 181 | 758 | 150 | 9 | 100 | 1385 |
| F. ... | 154 | 204 | 150 | 486 | 19 | 91 | 1104 |
| W. ... | 3 | 29 | 9 | 19 | 18 | 11 | 89 |
| R. ... | 136 | 103 | 100 | 91 | 11 | 558 | 999 |
| Totals ... | 1774 | 2133 | 1385 | 1104 | 89 | 999 | 7484 |

TABLE *v*.

First Sister.

| Second Sister. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 854 | 221 | 117 | 111 | 7 | 132 | 1442 |
| M. Bk. ... | 221 | 1194 | 185 | 169 | 20 | 82 | 1871 |
| Bd. ... | 117 | 185 | 734 | 115 | 22 | 85 | 1258 |
| F. ... | 111 | 169 | 115 | 454 | 9 | 71 | 929 |
| W. ... | 7 | 20 | 22 | 9 | 18 | 17 | 93 |
| R. ... | 132 | 82 | 85 | 71 | 17 | 562 | 949 |
| Totals ... | 1442 | 1871 | 1258 | 929 | 93 | 949 | 6542 |

TABLE *ω*.

Brother.

| Sister. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 887 | 340 | 127 | 119 | 5 | 131 | 1609 |
| M. Bk. ... | 276 | 1288 | 165 | 262 | 21 | 102 | 2114 |
| Bd. ... | 170 | 213 | 745 | 133 | 5 | 82 | 1348 |
| F. ... | 148 | 176 | 143 | 469 | 29 | 115 | 1080 |
| W. ... | 15 | 22 | 20 | 10 | 16 | 9 | 92 |
| R. ... | 116 | 72 | 100 | 94 | 10 | 540 | 932 |
| Totals ... | 1612 | 2111 | 1300 | 1087 | 86 | 979 | 7175 |

TABLE *μμ*.

First Brother.

| Second Brother. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 98 | 43 | 47 | 12 | 2 | 30 | 232 |
| M. Bk. ... | 43 | 92 | 27 | 18 | 4 | 16 | 200 |
| Bd. ... | 47 | 27 | 144 | 26 | 2 | 34 | 280 |
| F. ... | 12 | 18 | 26 | 52 | 2 | 31 | 141 |
| W. ... | 2 | 4 | 2 | 2 | — | 1 | 11 |
| R. ... | 30 | 16 | 34 | 31 | 1 | 68 | 180 |
| Totals ... | 232 | 200 | 280 | 141 | 11 | 180 | 1044 |

TABLE *νν*.

First Sister.

| Second Sister. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 88 | 48 | 48 | 24 | 2 | 28 | 238 |
| M. Bk. ... | 48 | 50 | 21 | 22 | 2 | 11 | 154 |
| Bd. ... | 48 | 21 | 142 | 19 | 4 | 23 | 257 |
| F. ... | 24 | 22 | 19 | 48 | 9 | 23 | 145 |
| W. ... | 2 | 2 | 4 | 9 | — | 3 | 20 |
| R. ... | 28 | 11 | 23 | 23 | 3 | 108 | 196 |
| Totals ... | 238 | 154 | 257 | 145 | 20 | 196 | 1010 |

TABLE *ωω*.

Brother.

| Sister. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 93 | 53 | 41 | 22 | 1 | 15 | 225 |
| M. Bk. ... | 49 | 63 | 31 | 16 | 2 | 17 | 178 |
| Bd. ... | 38 | 36 | 143 | 21 | 2 | 29 | 269 |
| F. ... | 17 | 23 | 29 | 42 | 2 | 33 | 146 |
| W. ... | 2 | 3 | 3 | 1 | 1 | 6 | 16 |
| R. ... | 36 | 19 | 22 | 31 | 1 | 88 | 197 |
| Totals ... | 235 | 197 | 269 | 133 | 9 | 188 | 1031 |

TABLE *μμμ*.

First Brother.

| Second Brother. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 220 | 119 | 72 | 37 | 1 | 47 | 496 |
| M. Bk. ... | 119 | 122 | 71 | 47 | 16 | 29 | 504 |
| Bd. ... | 72 | 71 | 298 | 54 | 10 | 55 | 560 |
| F. ... | 37 | 47 | 54 | 78 | 2 | 43 | 261 |
| W. ... | 1 | 16 | 10 | 2 | 2 | 1 | 32 |
| R. ... | 47 | 29 | 55 | 43 | 1 | 116 | 291 |
| Totals ... | 496 | 504 | 560 | 261 | 32 | 291 | 2144 |

TABLE *νν*.

First Sister.

| Second Sister. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 262 | 84 | 76 | 39 | 2 | 37 | 500 |
| M Bk. ... | 84 | 168 | 67 | 42 | 5 | 13 | 379 |
| Bd. ... | 76 | 67 | 330 | 57 | 8 | 44 | 582 |
| F. ... | 39 | 42 | 57 | 112 | 4 | 31 | 285 |
| W. ... | 2 | 5 | 8 | 4 | 6 | 2 | 27 |
| R. ... | 37 | 13 | 44 | 31 | 2 | 102 | 229 |
| Totals ... | 500 | 379 | 582 | 285 | 27 | 229 | 2002 |

TABLE *ωωω*.

Brother.

| Sister. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 319 | 137 | 115 | 65 | 3 | 51 | 690 |
| M. Bk. ... | 118 | 239 | 75 | 56 | 15 | 29 | 532 |
| Bd. ... | 108 | 89 | 444 | 78 | 16 | 78 | 813 |
| F. ... | 49 | 61 | 82 | 157 | 4 | 69 | 422 |
| W. ... | 3 | 8 | 14 | 5 | — | 6 | 36 |
| R. ... | 50 | 36 | 61 | 55 | 1 | 168 | 371 |
| Totals ... | 647 | 570 | 791 | 416 | 39 | 401 | 2864 |

TABLE $\mu\mu\mu\mu$.

First Brother.

| Second Brother. | P. Bk. | M. Bk. | Bd. | F. | W. | R. | Totals |
|---|---|---|---|---|---|---|---|
| P. Bk. ... | 250 | 83 | 58 | 45 | — | 42 | 478 |
| M. Bk. ... | 83 | 350 | 60 | 51 | 8 | 27 | 579 |
| Bd. ... | 58 | 60 | 222 | 45 | 3 | 20 | 408 |
| F. ... | 45 | 51 | 45 | 132 | 6 | 28 | 307 |
| W. ... | — | 8 | 3 | 6 | 8 | 4 | 29 |
| R. ... | 42 | 27 | 20 | 28 | 4 | 164 | 285 |
| Totals ... | 478 | 579 | 408 | 307 | 29 | 285 | 2086 |

## APPENDIX II.

*Classified Colour Inheritance Tables.*


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The following is the complete series of colour and colour combinations we have met with. In each case the order of the colour is supposed to indicate their relative predominance. In the tables A—D, M—O, first compiled, particoloured

dogs were grouped into single classes and not distinguished by placing the predominant colour first. Some breeders decline to distinguish between red and fawn; hence the category R. or F. Where ǀ occurs between two columns or rows in a table, it means that one or more colours do not occur in that table at the point indicated.

1. R. = Red.
2. R. F. = Red and Fawn.
3. R. or F. = Red or Fawn.
4. F. R. = Fawn and Red.
5. R. W. = Red and White.
6. W. R. = White and Red.
7. R. F. W. = Red, Fawn and White.
8. F. R. W. = Fawn, Red and White.
9. W. R. F. = White, Red and Fawn.
10. W. F. R. = White, Fawn and Red.
11. R. or F. W. = Red or Fawn and White.
12. W. R. or F. = White and Red or Fawn.
13. Bd. = Brindle.
14. Bd. Bk. = Brindle and Black.
15. Bk. Bd. = Black and Brindle.
16. Bd. W. = Brindle and White.
17. W. Bd. = White and Brindle.
18. Bd. F. = Brindle and Fawn.
19. F. Bd. = Fawn and Brindle.
20. R. or Bd. = Red or Brindle.
21. R. Bd. = Red and Brindle.
22. R. Bd. W. = Red, Brindle and White.
23. R. Tk. Bk. = Red, Ticked Black.
24. R. Bk. Pts. = Red, Black Points.
25. R. Bk. = Red and Black.
26. R. Bk. W. = Red, Black and White.
27. F. = Fawn.
28. F. W. = Fawn and White.
29. W. F. = White and Fawn.
30. Bd. F. W. = Brindle, Fawn and White.
31. F. Bd. W. = Fawn, Brindle and White.
32. Bd. or F. W. = Brindle or Fawn and White.
33. W. = White.
34. Be. W. = Blue and White.
35. W. Be. = White and Blue.
36. Be. Bd. = Blue Brindle.
37. Be. Bd. Tk. = Blue, Brindle, Ticked.
38. Be. Bd. W. = Blue, Brindle and White.
39. W. Be. Bd. = White, Blue and Brindle.
40. Be. Tk. = Blue Ticked.
41. Be. F. = Blue and Fawn.
42. Be. = Blue.
43. Be. Bk. = Blue and Black.
44. Bk. Be. W. = Black, Blue and White.
45. Be. Bk. W. = Blue, Black and White.
46. Bk. Bd. W. = Black, Brindle and White.
47. Bk. W. = Black and White.
48. W. Bk. = White and Black.
49. Bk. Tk. = Black Ticked.
50. Bk. W. Tk. = Black and White Ticked.
51. W. Bk. Tk. = White and Black Ticked.
52. W. Tk. = White Ticked.
53. F. Bk. = Fawn and Black.
54. F. Bk. W. = Fawn, Black and White.
55. Bk. = Black.

TABLE A.

*Sire and Offspring ♂.*

Sire.

Offspring ♂.

| | R. | R. F. | R. or F. | R. W. | R. or F. W. | Bd. | Bd. W. | F. | F. W. | Be. | Be. Bd. | Be. W. | W. | Bd. F. W. | Be. Bd. W. | Be. Tk. | Be. | Be. Bk. | Bk. Bd. W. | Bk. W. | Bk. W. Tk. | W. Bk. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. | 59 | 1 | 2 | 8 | — | 12 | 11 | 19 | 26 | — | 1 | 1 | — | — | — | — | 7 | — | — | 10 | 5 | — | 31 | 193 |
| R. F. | 2 | — | — | — | — | — | 1 | 5 | 2 | — | — | 1 | — | — | — | — | 1 | — | — | — | — | — | — | 12 |
| R. or F. | 5 | — | 6 | — | — | — | — | 4 | 4 | — | — | — | — | — | — | — | — | — | — | 1 | — | 2 | — | 22 |
| R. W. | 16 | — | — | 2 | — | 6 | 5 | 1 | 33 | — | — | 2 | — | — | — | — | — | — | 2 | 8 | — | — | 14 | 89 |
| R. F. W. | — | — | — | — | — | — | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| R. or F. W. | — | — | — | — | — | — | — | 1 | 10 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bd. | 41 | 3 | 7 | 4 | — | 113 | 24 | 19 | 10 | — | 3 | 1 | — | — | — | — | 7 | 1 | 1 | 24 | — | — | 27 | 286 |
| Bd. Bk. | — | — | — | — | — | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| Bd. W. | 13 | — | 3 | 7 | — | 32 | 45 | 2 | 22 | 3 | 3 | 2 | — | — | — | — | 2 | — | 1 | 25 | — | — | 11 | 171 |
| F. Bd. | — | — | — | — | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 3 |
| R. Bk. | 5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 5 |
| F. | 19 | 1 | 4 | — | — | 24 | 15 | 46 | 18 | — | 3 | 2 | — | — | — | — | 13 | — | 1 | 16 | 1 | — | 31 | 194 |
| F. W. | 20 | — | 3 | 1 | — | 11 | 9 | 21 | 44 | 2 | 1 | 4 | — | — | — | — | 3 | — | — | 32 | — | — | 20 | 171 |
| Bd. F. W. | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 3 |
| W. | 3 | — | — | — | — | 1 | 1 | 1 | — | — | — | — | 9 | — | — | — | 2 | — | — | 4 | — | — | 1 | 13 |
| Be. W. | 2 | — | — | 2 | — | 2 | 10 | 8 | — | — | — | — | — | — | — | — | 3 | — | — | 13 | — | — | 3 | 52 |
| Be. Bd. | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Be. Tk. | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Be. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | 1 |
| Bk. Bd. W. | — | — | — | — | — | 6 | 6 | 8 | 1 | — | 1 | 14 | — | — | — | — | 28 | 1 | — | 13 | 2 | — | 24 | 106 |
| Bk. W. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 |
| W. Bk. Tk. | 17 | — | 14 | 6 | 1 | 27 | 32 | 14 | 54 | — | — | 18 | — | — | — | — | 6 | 1 | — | 247 | 4 | — | 69 | 510 |
| F. Bk. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | 1 | 2 |
| F. Bk. W. | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 1 | — | — | 6 | 8 |
| Bk. | 38 | — | 14 | 5 | — | 48 | 23 | 22 | 13 | — | — | 24 | — | — | — | — | 33 | 1 | 2 | 101 | 7 | 3 | 204 | 542 |
| Totals | 240 | 5 | 53 | 37 | 3 | 284 | 184 | 172 | 232 | 5 | 11 | 78 | 5 | 3 | 1 | 1 | 106 | 4 | 7 | 498 | 19 | 5 | 443 | 2392 |

TABLE B.

*Sire and Offspring* ♀.

| Offspring ♀. | Sire. R. | R. or F. | R. W. | R. or F. W. | Bd. | Bd. W. | F. | F. W. | W. | Be. W. | Be. Bd. | Be. Bd. W. | Be. | Be. Bk. | Bk. W. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... ... | 79 | 5 | 3 | — | 12 | 5 | 13 | 31 | — | — | — | — | 5 | — | 14 | 23 | 190 |
| R. F. ... | 2 | — | — | — | 3 | 2 | 3 | 4 | — | — | — | — | 1 | — | 1 | 4 | 20 |
| R. or F. ... | 4 | 6 | 1 | — | 1 | — | — | — | — | — | — | — | 1 | — | — | — | 22 |
| R. W. ... | 11 | — | 4 | — | 8 | 5 | 1 | 23 | — | — | — | — | — | — | 4 | 3 | 59 |
| R. F. W. ... | — | — | — | — | 2 | 2 | — | — | — | — | — | — | 1 | — | — | 1 | 6 |
| R. or F. W. ... | — | — | — | — | — | 1 | 1 | — | — | 2 | — | 1 | — | 1 | — | 1 | 3 |
| Bd. ... ... | 42 | 2 | 1 | — | 113 | 26 | 18 | 6 | — | — | — | — | 9 | — | 28 | 33 | 282 |
| Bd. W. ... | 13 | 1 | 2 | — | 34 | 43 | — | 16 | 2 | — | 1 | — | 1 | — | 25 | 8 | 146 |
| F. Bd. ... | — | — | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 2 |
| R. or Bd. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| R. Tk. Bk. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | 1 |
| F. ... ... | 23 | 10 | 1 | — | 24 | 7 | 50 | 25 | 2 | 5 | — | — | 6 | — | 22 | 24 | 199 |
| F. W. ... | 19 | 1 | 3 | — | 10 | 12 | 20 | 50 | 3 | 2 | — | — | 2 | — | 14 | 14 | 150 |
| Bd. or F. W. ... | — | — | 1 | — | — | — | 1 | — | — | — | — | — | — | — | 2 | — | 4 |
| W. ... ... | 1 | 2 | — | — | 1 | 2 | 1 | 7 | 3 | 1 | — | — | 2 | — | 4 | 2 | 26 |
| Be. W. ... | 1 | — | 3 | — | 3 | 8 | 1 | 3 | — | 5 | — | — | 6 | — | 9 | 10 | 49 |
| Be. Bd. ... | — | — | — | — | 1 | 2 | — | — | — | — | — | — | 3 | — | — | — | 6 |
| Be. F. ... | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 |
| Be. ... W. ... | 1 | — | — | — | 10 | 2 | 4 | — | — | 18 | — | — | 24 | 1 | 10 | 19 | 89 |
| Be. Bk. W. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 |
| Bk. W. ... | 28 | — | — | — | 15 | 27 | 17 | 51 | — | 16 | — | — | 7 | — | 243 | 56 | 470 |
| F. Bk. ... | — | 5 | 4 | 1 | — | — | — | 2 | — | — | — | — | — | — | — | 9 | 11 |
| Bk. ... ... | 32 | 9 | 7 | — | 40 | 10 | 25 | 14 | — | 26 | — | — | 22 | — | 99 | 209 | 493 |
| Totals | 256 | 41 | 31 | 1 | 278 | 154 | 163 | 232 | 10 | 75 | 1 | 1 | 91 | 2 | 479 | 416 | 2231 |

TABLE C.

*Dam and Offspring ♂.*

| Offspring ♂ | R. | R. F. | R. or F. | R. W. | R. F. W. | R. or F. W. | Bd. | Bd. W. | F. Bd. | R. Bk. W. | R. | F. W. | W. | Be. W. | Be. F. | Be. | Bk. W. | Bk. W. Tk. | F. Bk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 63 | 2 | 1 | 16 | 2 | — | 13 | 7 | — | — | 19 | 16 | — | 2 | — | 2 | 21 | 3 | 2 | 38 | 207 |
| R F. ... | 8 | — | — | — | — | — | 3 | — | — | — | — | — | — | — | — | — | 1 | — | — | 3 | 15 |
| R. or F. ... | 4 | — | 6 | — | — | — | 6 | — | — | — | — | — | — | — | — | — | 6 | — | — | — | 22 |
| R. W. ... | 18 | — | — | 15 | 1 | — | 3 | 12 | — | — | 4 | 20 | — | — | — | — | 8 | — | — | 1 | 84 |
| R. F. W. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 2 |
| R. or F. W. ... | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 1 | — | — | — | 2 |
| Bd. ... | 23 | — | 3 | 9 | — | 1 | 99 | 32 | 1 | — | 34 | 3 | 2 | 5 | — | 3 | 13 | 4 | — | 58 | 290 |
| Bd. Bk. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bd. W. ... | 10 | 5 | — | 5 | — | — | 32 | 42 | — | — | 9 | 11 | 6 | 6 | — | 2 | 34 | — | — | 12 | 174 |
| F. Bd. ... | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 3 |
| R. Bk. Pts. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 |
| F. W. ... | 24 | 6 | 1 | 6 | 1 | 2 | 23 | 3 | 1 | 1 | 54 | 16 | — | 5 | 1 | 6 | 20 | — | — | 20 | 190 |
| F. W. ... | 7 | 2 | 1 | 9 | — | — | 14 | 20 | — | — | 19 | 27 | 7 | 4 | — | 12 | 37 | — | — | 14 | 173 |
| Bd. F. W. ... | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 1 |
| W. ... | — | — | — | — | — | — | 1 | 3 | — | — | 2 | 3 | 3 | 6 | — | — | 8 | — | — | 2 | 33 |
| Be. W. ... | 2 | — | — | 5 | — | — | — | 1 | — | — | 3 | 6 | 2 | 11 | — | 2 | 12 | 1 | — | 9 | 51 |
| Be. Bd. ... | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 |
| Be. Bd. W. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 2 |
| Be. F. ... | 1 | — | 1 | — | — | — | 5 | — | — | — | — | — | — | 3 | — | 11 | — | — | — | — | 1 |
| Be. ... | 12 | — | 2 | — | — | — | — | — | — | — | 18 | 2 | — | — | — | 13 | 15 | — | — | 37 | 105 |
| Bk. W. ... | 21 | 1 | — | 16 | 2 | 3 | 26 | 31 | — | — | 28 | 55 | 13 | 38 | — | 13 | 189 | 2 | — | 71 | 509 |
| Bk. W. Tk. ... | — | — | — | — | — | — | — | 1 | — | — | 1 | — | — | — | — | — | 1 | — | — | — | 3 |
| W. Bk. Tk. ... | 6 | — | — | — | — | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| F. Bk. ... | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 7 |
| Bk. ... | 58 | 1 | — | 7 | — | — | 41 | 11 | — | 1 | 45 | 14 | 5 | 7 | 1 | 13 | 71 | 6 | — | 259 | 540 |
| Totals | 257 | 18 | 16 | 90 | 6 | 6 | 269 | 165 | 2 | 2 | 236 | 174 | 39 | 88 | 2 | 65 | 440 | 17 | 2 | 525 | 2419 |

## TABLE D.

*Dam and Offspring ♀.*

Dam.

| Offspring ♀. | R. | R. F. | R. or F. | R. W. | R. F. W. | R. or F. W. | Bd. | Bd. W. | F. Bd. | R. Bk. W. | F. | F. W. | W. | Be. W. | Be. F. | Be. | Bk. W. | Bk. W. Tk. | F. Bk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... ... | 67 | 3 | 4 | 23 | — | — | 15 | 11 | — | — | 17 | 11 | — | 3 | — | 1 | 16 | 2 | — | 24 | 197 |
| R. F. ... | 12 | — | — | 2 | — | — | 1 | — | — | — | 3 | — | — | 1 | — | 1 | — | — | — | 2 | 22 |
| R. or F. ... | 2 | — | 6 | — | — | — | 4 | 1 | — | — | — | — | — | 1 | — | — | 1 | — | — | 6 | 21 |
| R. W. ... | 19 | — | — | 6 | 1 | — | 1 | 6 | — | — | 5 | 7 | 2 | 1 | — | — | 5 | — | — | 7 | 60 |
| R. F. W. ... | 1 | — | — | 1 | — | — | 2 | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 5 |
| R. or F. W. | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | 3 |
| Bd. ... ... | 26 | 1 | 6 | 11 | — | 4 | 90 | 23 | 2 | — | 30 | 2 | — | 6 | — | 6 | 27 | 2 | — | 44 | 280 |
| Bd. W. ... | 11 | 2 | 3 | 3 | — | — | 19 | 40 | — | 1 | 4 | 10 | 5 | 6 | — | 3 | 32 | — | — | 11 | 150 |
| F. Bd. ... | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | 1 |
| R. or Bd. ... | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 1 |
| R. Tk. Bk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| F. ... ... | 18 | 2 | — | 15 | 1 | 2 | 23 | 1 | — | 1 | 51 | 11 | 3 | 2 | 3 | 8 | 22 | — | 1 | 34 | 198 |
| F. W. ... | 10 | 1 | — | 13 | — | — | 8 | 15 | 1 | 1 | 17 | 17 | 7 | 3 | 1 | 14 | 25 | 1 | 1 | 16 | 151 |
| Bd. F. W. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 |
| Bd. or F. W. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| W. ... ... | — | — | — | 4 | — | — | 3 | 5 | — | — | 2 | 3 | 4 | 2 | — | 2 | 5 | — | — | 1 | 31 |
| Be. W. ... | 2 | — | — | 1 | — | — | 1 | 1 | — | — | — | 6 | 5 | 8 | — | 3 | 13 | — | — | 6 | 46 |
| Be. Bd. ... | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | 3 | — | — | — | 1 | 6 |
| Be. F. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Be. ... ... | 8 | — | 4 | — | — | — | 6 | 1 | — | — | 21 | 3 | 2 | 3 | 1 | 3 | 6 | 1 | — | 28 | 87 |
| Be. Bk. W. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bk. W. ... | 9 | 4 | — | 23 | — | 1 | 23 | 24 | — | 1 | 24 | 46 | 7 | 52 | — | 16 | 170 | 1 | — | 60 | 461 |
| F. Bk. ... | 9 | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | 11 |
| Bk. ... ... | 56 | 2 | — | 3 | 1 | — | 39 | 9 | — | 1 | 30 | 17 | — | 9 | — | 14 | 63 | 10 | — | 247 | 501 |
| Totals | 251 | 16 | 23 | 105 | 3 | 7 | 238 | 139 | 3 | 5 | 205 | 135 | 35 | 97 | 5 | 74 | 388 | 17 | 2 | 489 | 2237 |

## TABLE AA.

*Sire and Offspring ♂.*

Sire.

| Offspring ♂. | R. | R. F. | R. W. | W. R. | R. F. W. | Bd. | Bd. W. | W. Bd. | F. | F. W. | W. F. | W. | Be. W. | W. Be. | Be. Bd. | Be. | Bk. W. | W. Bk. | Bk. Tk. | Bk. W. Tk. | W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 42 | 1 | — | 7 | — | 9 | 3 | 6 | 8 | 1 | 5 | — | — | — | — | — | — | 2 | 1 | — | — | 11 | 96 |
| R. F. ... | 7 | 1 | — | 1 | — | 2 | 1 | — | 5 | 3 | 1 | — | — | — | — | — | 1 | — | 1 | — | — | 4 | 27 |
| F. R. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 2 |
| R. W. ... | 5 | — | — | 1 | — | 3 | 5 | 1 | 3 | — | 2 | — | — | — | — | — | 2 | — | — | — | — | 1 | 23 |
| W. R. ... | 4 | — | — | 3 | — | 2 | — | 2 | — | — | 7 | — | — | 2 | — | — | — | — | — | — | — | 1 | 21 |
| R. F. W. ... | — | — | — | — | 1 | — | — | — | 1 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 3 |
| F. R. W. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. R. F. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bd. ... | 19 | 2 | — | 3 | — | 62 | 15 | 10 | 4 | 4 | 6 | — | 1 | — | 4 | 3 | 12 | 4 | — | — | — | 10 | 159 |
| Bd. W. ... | 3 | — | — | 2 | — | 9 | 11 | 6 | 1 | — | 4 | — | — | — | 2 | — | — | — | — | — | — | 3 | 41 |
| W. Bd. ... | 9 | — | — | — | — | 5 | 7 | 9 | — | — | 7 | — | — | — | 1 | — | 2 | 1 | — | — | — | 2 | 43 |
| F. Bd. ... | — | — | — | — | — | — | 2 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 3 |
| Bd. F. ... | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 |
| R. Bd. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 1 |
| R. Bd. W. ... | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| F. ... | 21 | 5 | 1 | — | — | 6 | 5 | 2 | 20 | 3 | 1 | — | 3 | — | 1 | 7 | 3 | 1 | 1 | 1 | 1 | 8 | 90 |
| F. W. ... | 3 | — | 1 | — | — | 7 | 1 | 1 | 4 | 2 | 1 | — | 1 | — | — | 1 | 1 | 1 | — | — | — | 2 | 26 |
| W. F. ... | 8 | — | 4 | 1 | — | — | — | — | 1 | — | 2 | — | — | — | 1 | — | 2 | 1 | — | — | — | 1 | 21 |
| W. ... | 2 | — | 2 | — | — | 1 | 1 | — | 1 | — | 1 | — | — | — | — | 1 | 2 | — | — | — | — | — | 11 |
| Be. W. ... | 1 | — | 1 | — | 1 | 3 | 1 | — | 1 | — | — | — | — | — | — | 1 | — | 1 | — | — | — | — | 10 |
| W. Be. ... | — | — | — | — | — | — | — | 1 | 1 | — | 1 | — | — | — | — | 4 | 1 | — | — | — | — | — | 8 |
| Be. Bd. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| W. Be. Bd. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 1 |
| Be. F. ... | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Be. ... | 4 | — | — | — | — | 4 | — | 1 | 5 | — | 1 | 2 | — | — | 1 | 6 | 5 | 1 | 1 | — | — | 4 | 35 |
| Bk. W. ... | 3 | — | 4 | — | 1 | 4 | 12 | 2 | 4 | — | 6 | — | — | — | 1 | 2 | 24 | 5 | 2 | — | — | 15 | 85 |
| W. Bk. ... | 5 | — | — | 2 | — | 4 | 4 | 1 | 1 | — | 7 | — | 1 | — | — | — | 6 | 2 | — | — | — | 4 | 37 |
| Bk. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | 1 |
| W. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 | 1 |
| Bk. ... | 32 | — | — | 4 | — | 33 | 6 | 1 | 10 | 1 | 6 | 1 | 2 | 1 | 2 | 9 | 20 | 20 | 2 | 2 | 1 | 59 | 212 |
| Totals | 170 | 9 | 13 | 25 | 3 | 154 | 75 | 44 | 70 | 15 | 59 | 3 | 8 | 3 | 13 | 35 | 85 | 39 | 8 | 3 | 2 | 127 | 963 |

## TABLE BB.

*Sire and Offspring ♀.*

Sire.

Offspring ♀.

| | R. | R. F. | R. W. | W. R. | R. F. W. | Bd. | Bd. W. | W. Bd. | F. | F. W. | W. F. | W. | Be. W. | W. Be. | Be. Bd. | Be. | Bk. W. | W. Bk. | Bk. Tk. | Bk. W. Tk. | W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 39 | 1 | — | 3 | — | 8 | 3 | 2 | 11 | 1 | 3 | — | — | 1 | 5 | 4 | 1 | — | 1 | 1 | 1 | 8 | 93 |
| R. F. ... | 13 | — | — | 1 | — | 6 | 1 | 2 | 3 | — | — | — | — | — | — | 2 | — | — | — | 1 | — | 4 | 33 |
| F. R. ... | — | 1 | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 |
| R. W. ... | 5 | — | 1 | — | — | 3 | 1 | 2 | 2 | — | 1 | — | — | — | — | — | — | 2 | — | — | — | — | 17 |
| W. R. ... | 5 | — | — | 2 | — | 1 | — | 1 | — | — | 7 | — | — | — | — | — | — | — | — | — | — | 1 | 17 |
| R. F. W.... | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| W. F. R.... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| Bd. ... | 23 | 1 | — | 3 | 1 | 55 | 19 | 6 | 6 | 4 | 8 | — | 1 | 1 | 6 | 5 | 12 | 4 | — | 1 | — | 17 | 173 |
| Bd. W. ... | 5 | — | — | — | — | 11 | 6 | 2 | 2 | 1 | 4 | — | — | — | 1 | — | 4 | — | — | — | — | 1 | 37 |
| W. Bd. ... | 1 | — | — | — | — | 3 | 11 | 6 | 1 | — | 6 | — | — | — | 1 | — | 3 | — | — | — | — | 6 | 38 |
| F. ... | 20 | 3 | — | 3 | — | 11 | 2 | 2 | 16 | 2 | 3 | — | — | — | — | 4 | 4 | — | — | — | — | 9 | 79 |
| F. W. ... | 8 | 1 | 1 | — | — | 2 | 8 | 1 | 3 | 2 | 1 | — | 1 | — | — | 2 | 1 | — | — | — | — | 3 | 34 |
| W. F. ... | 5 | — | 2 | — | — | — | 2 | 3 | 5 | 1 | 3 | — | — | — | — | — | — | 2 | — | — | — | — | 23 |
| W. ... | 5 | — | — | — | — | 1 | 2 | 4 | — | 1 | 2 | — | — | — | — | — | — | — | — | — | — | 1 | 16 |
| Be. W. ... | 2 | — | — | — | — | 1 | — | — | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | 5 |
| W. Be. ... | — | — | — | 1 | — | — | 1 | — | — | — | 3 | — | — | — | — | 2 | — | — | — | — | — | — | 7 |
| Be. ... | 1 | 1 | 1 | — | — | 3 | 1 | 3 | 1 | 1 | — | 1 | — | — | — | 2 | 5 | 1 | 2 | — | — | 5 | 28 |
| Bk. W. ... | 5 | — | 3 | — | — | 7 | 5 | — | 3 | — | 5 | — | 3 | — | — | 2 | 11 | 3 | 1 | 1 | — | 5 | 54 |
| W. Bk. ... | 8 | — | — | 1 | — | 3 | 4 | 1 | 3 | — | 8 | — | 2 | 1 | — | — | 2 | 3 | — | — | — | 2 | 38 |
| Bk. Tk. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 2 |
| W. Bk. Tk. | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. Tk. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bk. ... | 37 | 4 | — | 6 | — | 38 | 6 | 3 | 8 | 2 | 8 | — | 4 | — | 1 | 9 | 29 | 6 | 3 | 2 | 1 | 44 | 211 |
| Totals | 186 | 12 | 8 | 21 | 1 | 153 | 72 | 38 | 66 | 16 | 63 | 1 | 11 | 3 | 14 | 32 | 72 | 21 | 7 | 6 | 2 | 108 | 913 |

## TABLE CC.

*Dam and Offspring ♂.*

Dam.

| Offspring ♂. | R. | R. F. | R. or F. | F. R. | R. W. | W. R. | Bd. | Bd. W. | W. Bd. | Bd. F. | F. Bd. | F. | F. W. | W. F. | W. | Be. W. | W. Be. | Be. | Bk. W. | W. Bk. | Bk. Tk. | Bk. W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R.... ... | 23 | 8 | 2 | — | 4 | 2 | 14 | 2 | 1 | — | — | 6 | 5 | 2 | — | — | — | 3 | 7 | 2 | — | 1 | 14 | 96 |
| R. F. ... | 3 | 2 | — | — | 3 | 1 | 2 | — | — | — | — | 4 | — | 1 | — | — | — | 1 | 2 | — | — | — | 8 | 27 |
| F. R. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 2 |
| R. W. ... | 6 | 1 | — | — | 2 | 3 | 2 | — | 1 | — | — | — | 1 | 3 | — | — | — | — | 2 | — | — | — | 2 | 23 |
| W. R. ... | 2 | 1 | — | — | — | 2 | 3 | — | 5 | — | — | 2 | 1 | — | 1 | — | 1 | — | 3 | — | — | — | 1 | 21 |
| R. F. W.... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 | — | — | — | — | 3 |
| F. R. W.... | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. R. F.... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| Bd. ... | 20 | 7 | — | 2 | — | 1 | 45 | 8 | 6 | — | 2 | 10 | 3 | 4 | — | 3 | — | 1 | 20 | 2 | — | 1 | 24 | 159 |
| Bd. W. ... | 3 | 1 | — | — | — | 1 | 14 | 1 | 5 | — | — | 1 | 3 | 1 | — | — | — | — | 5 | 2 | — | — | 4 | 41 |
| W. Bd. ... | 1 | 1 | — | 1 | — | — | 8 | 1 | 7 | — | 2 | — | 1 | — | — | — | — | 1 | 5 | 9 | 2 | — | 4 | 43 |
| Bd. F. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| F. Bd. ... | — | — | — | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 3 |
| R. Bd. ... | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| R. Bd. W. | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| F. ... | 13 | 1 | 1 | — | 3 | 2 | 15 | 3 | 2 | — | — | 17 | 6 | 4 | — | — | — | 2 | 12 | 1 | — | 1 | 7 | 90 |
| F. W. ... | 1 | — | — | — | — | 3 | 1 | 1 | 1 | — | — | 4 | 3 | 2 | — | — | 1 | 1 | 5 | 2 | — | — | 1 | 26 |
| W. F. ... | 1 | 1 | — | — | 2 | — | 1 | — | 1 | — | — | 2 | 1 | 6 | — | — | — | — | 3 | 1 | — | — | 2 | 21 |
| W. ... | 1 | — | — | — | 1 | — | — | 1 | 3 | — | — | — | — | 1 | 1 | — | — | — | 2 | 1 | — | — | — | 11 |
| Be. W. ... | 1 | — | — | — | — | — | — | — | — | — | — | 1 | 2 | — | — | 1 | 1 | — | 2 | 2 | — | — | — | 10 |
| W. Be. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | 1 | 1 | 3 | — | — | — | 8 |
| Be. Bd. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. Be. Bd. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 |
| Be. F. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Be. ... | 4 | — | — | — | — | — | 3 | 1 | — | — | — | — | 2 | — | — | — | — | 4 | 4 | 1 | — | 1 | 15 | 35 |
| Bk. W. ... | 5 | 3 | — | — | 3 | — | 6 | 4 | 1 | — | — | 4 | 7 | 1 | — | 1 | 2 | 2 | 20 | 5 | 1 | — | 20 | 85 |
| W. Bk. ... | 2 | — | — | — | — | 1 | 1 | — | — | — | — | 1 | — | — | — | — | 1 | 1 | 7 | 13 | 1 | — | 9 | 37 |
| Bk. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 |
| W. Tk. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bk. ... ... | 18 | 1 | — | — | 1 | 1 | 18 | 7 | 1 | 3 | — | 10 | 2 | 2 | — | 2 | 3 | 7 | 51 | 11 | 1 | 5 | 68 | 212 |
| Totals | 106 | 27 | 3 | 4 | 19 | 17 | 139 | 30 | 35 | 3 | 4 | 62 | 37 | 29 | 2 | 7 | 8 | 24 | 156 | 56 | 5 | 9 | 181 | 963 |

## TABLE DD.

*Dam and Offspring ♀.*

Dam.

| Offspring ♀. | R. | R. F. | R. or F. | F. R. | R. W. | W. R. | Bd. | Bd. W. | W. Bd. | Bd. F. | F. Bd. | F. | F. W. | W. F. | W. | Be. W. | W. Bc. | Be. | Bk. W. | W. Bk. | Bk. Tk. | Bk. W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 26 | 4 | 1 | — | 6 | 1 | 10 | 1 | — | — | — | 6 | 4 | 4 | — | — | — | 3 | 13 | 4 | — | — | 10 | 93 |
| R. F. ... | 6 | 1 | — | — | 3 | 2 | 3 | — | — | — | — | 1 | 3 | 1 | — | — | — | 1 | 3 | — | — | — | 9 | 33 |
| F. R. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 | — | — | — | — | 3 |
| R. W. ... | 5 | 2 | — | — | 1 | 1 | 2 | — | 1 | — | — | 1 | 1 | 1 | — | — | — | — | 2 | — | — | — | — | 17 |
| W. R. ... | 1 | — | — | — | — | — | 2 | 1 | 3 | — | — | 2 | 1 | — | — | — | — | — | 3 | 1 | — | — | 3 | 17 |
| R. F. W. ... | — | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | 2 |
| W. F. R. ... | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bd. ... | 19 | 6 | — | — | — | 2 | 56 | 7 | 9 | — | 1 | 15 | 4 | 3 | — | 2 | — | 3 | 18 | 4 | 1 | 1 | 22 | 173 |
| Bd. W. ... | 3 | 1 | — | — | 2 | 1 | 11 | 1 | 4 | — | — | 1 | — | — | — | — | 1 | — | 5 | 1 | — | 2 | 4 | 37 |
| W. Bd. ... | 2 | 1 | — | 3 | 1 | — | 5 | — | 5 | — | 1 | 1 | — | 1 | — | 2 | — | 1 | 4 | 8 | — | — | 3 | 38 |
| F. ... | 4 | — | — | — | — | 2 | 13 | 1 | 2 | 1 | — | 16 | 6 | 5 | — | 2 | — | 4 | 8 | 2 | — | — | 13 | 79 |
| F. W. ... | 3 | — | — | 1 | — | — | 5 | 2 | 1 | — | — | 5 | 3 | 5 | — | — | — | — | 4 | 1 | — | — | 4 | 34 |
| W. F. ... | 1 | 2 | — | — | 4 | — | 1 | — | 1 | — | — | 2 | 2 | 3 | — | 1 | 1 | — | 2 | 3 | — | — | — | 23 |
| W. ... | — | 2 | — | — | — | — | 1 | — | 1 | — | — | 2 | 1 | 2 | 1 | — | — | — | 1 | 3 | — | — | 2 | 16 |
| Be. W. ... | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 | — | — | 2 | — | — | — | 1 | 5 |
| W. Be. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 | 3 | — | — | 1 | 7 |
| Be. ... | 2 | — | — | — | 1 | — | 2 | — | — | — | — | 1 | 1 | 1 | — | — | — | 3 | 6 | — | — | 2 | 9 | 28 |
| Bk. W. ... | 2 | 1 | — | — | — | — | 6 | — | — | — | — | 2 | 5 | 3 | — | — | 1 | 1 | 19 | 2 | — | 2 | 10 | 54 |
| W. Bk. ... | 1 | — | — | — | — | 1 | 1 | — | 1 | — | — | — | 1 | 1 | 2 | — | 2 | 1 | 8 | 12 | — | — | 7 | 38 |
| Bk. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 | 2 |
| W. Bk. Tk. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| W. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bk. ... | 20 | 2 | — | — | 2 | 2 | 18 | 4 | — | 1 | — | 5 | 2 | 2 | — | 4 | 1 | 5 | 41 | 10 | 2 | 5 | 85 | 211 |
| Totals | 96 | 22 | 1 | 4 | 20 | 12 | 136 | 17 | 28 | 2 | 2 | 63 | 36 | 33 | 3 | 12 | 6 | 22 | 144 | 54 | 3 | 12 | 185 | 913 |

## TABLE E.

*Paternal Grandsire and Offspring ♂.*

Paternal Grandsire.

| Offspring ♂. | R. | R. or F. | R. W. | W. R. | Bd. | Bd. W. | W. Bd. | F. | F. W. | W. F. | Be. W. | W. Be. | Be. | Bk. W. | W. Bk. | Bk. Tk. | Bk. W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R.... ... | 43 | — | — | 1 | 9 | 6 | 1 | — | — | 3 | 1 | — | 11 | 5 | 1 | 1 | — | 14 | 96 |
| R. F. ... | 7 | — | — | — | 8 | 1 | — | 1 | — | — | — | — | 2 | 3 | 1 | — | — | 4 | 27 |
| F. R. ... | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 | 2 |
| R. W. ... | 8 | — | 1 | — | 1 | 6 | — | — | — | — | — | — | 2 | 2 | 1 | — | — | 1 | 22 |
| W. R. ... | 13 | — | — | — | 2 | — | 2 | — | — | — | — | — | — | 1 | 2 | — | — | 1 | 21 |
| R. F. W.... | — | 1 | — | — | 1 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 3 |
| W. R. F.... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| F. R. W.... | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 |
| Bd. ... | 24 | — | — | 1 | 18 | 10 | 13 | — | — | 5 | — | 1 | 18 | 12 | — | 2 | 2 | 53 | 159 |
| Bd. W. ... | 12 | — | — | — | 2 | 7 | 3 | 1 | — | 1 | — | — | 6 | 1 | — | — | — | 8 | 41 |
| W. Bd. ... | 15 | — | 2 | 1 | 5 | 1 | 4 | — | — | 1 | — | — | — | 3 | — | — | — | 11 | 43 |
| F. Bd. ... | 2 | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 3 |
| Bd. F. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| R. Bd. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 |
| R. Bd. W. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| F.... ... | 19 | — | — | — | 16 | 5 | 1 | 2 | — | 3 | — | — | 5 | 9 | — | 3 | 1 | 23 | 87 |
| F. W. ... | 7 | — | — | — | 2 | 2 | 1 | 1 | 1 | — | — | — | 6 | 1 | — | — | — | 5 | 26 |
| W. F. ... | 5 | — | — | — | 3 | 1 | — | — | — | 1 | 1 | — | 3 | 1 | 1 | — | — | 3 | 19 |
| W. ... | 4 | — | — | 1 | — | — | — | — | — | — | — | — | — | 2 | 1 | — | — | 3 | 11 |
| Be. W. ... | 2 | — | — | — | 3 | — | — | 1 | — | — | — | — | — | 1 | — | — | — | 3 | 10 |
| W. Be. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 | — | — | 5 | 8 |
| Be. Bd. ... | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. Be. Bd. | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Be. F. ... | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Be. ... | 8 | 1 | — | — | 1 | 3 | — | 1 | — | — | — | — | 6 | 2 | — | — | — | 13 | 35 |
| Bk. W. ... | 12 | 1 | — | — | 10 | 2 | 2 | 3 | — | — | — | — | 7 | 10 | — | — | — | 35 | 82 |
| W. Bk. ... | 11 | — | — | 1 | 4 | — | — | — | 2 | 1 | 2 | — | 1 | 1 | 1 | — | — | 13 | 37 |
| Bk. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| W. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| Bk. ... | 53 | 1 | 3 | 1 | 37 | 5 | 3 | 1 | — | — | — | 2 | 10 | 12 | 2 | 2 | 2 | 76 | 210 |
| Totals | 247 | 5 | 6 | 6 | 123 | 50 | 32 | 11 | 3 | 15 | 4 | 3 | 78 | 69 | 11 | 8 | 5 | 276 | 952 |

## TABLE F.

*Paternal Grandsire and Offspring ♀.*

Paternal Grandsire.

| Offspring ♀. | R. | R. or F. | R. W. | W. R. | Bd. | Bd. W. | W. Bd. | F. | F. W. | W. F. | Be. W. | W. Be. | Be. | Bk. W. | W. Bk. | Bk. Tk. | Bk. W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 39 | — | — | 1 | 9 | 13 | — | 1 | — | 1 | — | — | 9 | 5 | — | 1 | 1 | 12 | 92 |
| R. F. ... | 5 | — | — | — | 6 | 2 | 1 | 1 | — | — | — | — | 4 | 5 | 2 | — | 1 | 6 | 33 |
| F. R. ... | — | — | — | — | 3 | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 |
| R. W. ... | 4 | — | — | — | — | 1 | 1 | — | — | — | — | — | 1 | 2 | 2 | 1 | — | 4 | 16 |
| W. R. ... | 13 | — | — | — | — | — | — | — | 1 | — | — | — | 1 | — | — | — | — | 2 | 17 |
| R. F. W. ... | — | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | — | — | 2 |
| W. F. R. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 |
| Bd. ... | 39 | — | 1 | — | 22 | 12 | 10 | 1 | — | 3 | — | 1 | 14 | 9 | 1 | 2 | — | 55 | 170 |
| Bd. W. ... | 11 | — | 1 | — | 1 | 2 | 5 | 1 | — | — | — | — | 4 | — | — | — | — | 9 | 34 |
| W. Bd. ... | 8 | — | — | — | 6 | 2 | 5 | — | — | 3 | — | — | — | 4 | — | — | — | 10 | 38 |
| F. ... | 17 | — | 1 | 1 | 7 | 1 | 1 | 2 | — | 2 | 1 | — | 10 | 4 | 3 | 1 | — | 27 | 78 |
| F. W. ... | 14 | — | — | 1 | — | — | 1 | — | — | 1 | — | — | 4 | — | 1 | — | — | 7 | 29 |
| W. F. ... | 7 | — | — | 3 | 3 | — | 1 | — | — | 2 | — | — | 2 | — | — | — | — | 2 | 20 |
| W. ... | 7 | — | 1 | — | — | — | 1 | — | — | 1 | — | — | — | 1 | — | — | — | 4 | 15 |
| Be. W. ... | 1 | — | — | — | 1 | — | — | — | — | — | — | — | 2 | — | — | — | — | 1 | 5 |
| W. Be. ... | 1 | — | — | 1 | — | — | — | — | 2 | — | 1 | — | — | — | — | — | — | 2 | 7 |
| Be. ... | 6 | 1 | — | — | 3 | 2 | — | — | — | — | — | — | 2 | — | 2 | — | — | 12 | 28 |
| Bk. W. ... | 11 | 1 | — | — | 8 | — | 1 | 1 | — | — | — | — | 5 | 5 | 2 | — | — | 22 | 54 |
| W. Bk. ... | 16 | — | — | — | 7 | 2 | — | 3 | — | 1 | 1 | — | 1 | — | 2 | — | — | 5 | 38 |
| Bk. Tk. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 2 |
| W. Bk. Tk. | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | 1 |
| W. Tk. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bk. ... | 56 | — | — | — | 25 | 8 | 1 | 3 | 1 | 2 | 2 | 2 | 18 | 18 | 3 | 2 | 4 | 64 | 209 |
| Totals | 257 | 2 | 4 | 7 | 101 | 45 | 28 | 13 | 4 | 16 | 6 | 3 | 79 | 54 | 16 | 7 | 6 | 245 | 893 |

## TABLE G.

*Maternal Grandsire and Offspring ♂.*

Maternal Grandsire.

| Offspring ♂. | R. | R. F. | R. or F. | R. W. | W. R. | Bd. | Bd. W. | W. Bd. | F. | F. W. | W. F. | W. | Be. W. | Be. Tk. | Be. | Bk. W. | W. Bk. | Bk. Tk. | Bk. W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 20 | 2 | 5 | 4 | — | 12 | 5 | 2 | 8 | 1 | 1 | — | 1 | — | — | 3 | 3 | 4 | 1 | 24 | 96 |
| R. F. ... | 5 | — | 4 | — | — | 1 | 2 | 1 | 3 | — | 1 | — | — | — | — | 4 | — | — | — | 7 | 28 |
| F. R. ... | — | — | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| R. W. ... | 9 | 1 | — | 1 | — | 4 | — | 1 | 1 | — | — | — | — | — | — | 4 | 1 | — | — | — | 22 |
| W. R. ... | 1 | — | 1 | — | 1 | 3 | 1 | 2 | 2 | — | — | — | 1 | — | — | — | 4 | — | 1 | 4 | 21 |
| R. F. W. | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 2 | — | — | — | — | 3 |
| F. R. W.... | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. R. F.... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| Bd. ... | 39 | 1 | — | 1 | 1 | 27 | 6 | 7 | 5 | 2 | 2 | 2 | 3 | — | 3 | 13 | — | — | — | 43 | 155 |
| Bd. W. ... | 13 | — | — | — | — | 6 | — | 3 | 2 | — | — | — | 1 | — | 1 | 3 | 1 | — | — | 10 | 40 |
| W. Bd. ... | 8 | — | — | — | — | 4 | — | 2 | — | 3 | 1 | 1 | — | — | — | 2 | 4 | — | — | 18 | 43 |
| F. Bd. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | 3 |
| Bd. F. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| R. Bd. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 1 |
| R. Bd. W. | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| F. ... | 16 | — | — | 2 | — | 16 | 4 | 5 | 10 | 1 | 1 | — | — | — | 3 | 4 | 1 | — | 3 | 21 | 87 |
| F. W. ... | 4 | — | — | 2 | 1 | 2 | 1 | — | 3 | 2 | 1 | — | — | — | — | 4 | — | — | — | 6 | 26 |
| W. F. ... | 5 | — | 1 | — | — | 1 | — | 1 | 2 | — | — | — | — | — | 1 | 2 | 2 | — | — | 6 | 21 |
| W. ... | 3 | — | — | — | — | 1 | — | 1 | — | — | 1 | — | — | — | — | 1 | — | — | — | 3 | 10 |
| Be. W. ... | 2 | — | — | 1 | — | — | 1 | 4 | — | — | — | — | — | — | — | 1 | — | — | — | 1 | 10 |
| W. Be. ... | 1 | — | — | — | — | — | — | — | — | 1 | — | — | — | 2 | 2 | 1 | — | — | — | 1 | 8 |
| Be. Bd. ... | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. Be. Bd. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 |
| Be. F. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| Be. ... | 4 | 1 | 1 | 2 | — | 1 | 1 | 2 | 2 | — | — | — | — | — | 2 | 6 | — | — | — | 10 | 32 |
| Bk. W. ... | 11 | — | — | 2 | 1 | 11 | 2 | 5 | 2 | 1 | 5 | — | 1 | — | 1 | 17 | 4 | — | — | 17 | 80 |
| W. Bk. ... | 2 | — | — | — | — | 4 | 1 | 2 | 2 | — | — | — | — | — | 8 | 6 | 6 | — | — | 5 | 36 |
| Bk. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 |
| W. Tk. ... | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | 1 |
| Bk. ... | 23 | — | — | 5 | 2 | 28 | 11 | 1 | 7 | 1 | 6 | — | 1 | — | 15 | 32 | 11 | 3 | 4 | 56 | 206 |
| Totals | 167 | 5 | 13 | 20 | 6 | 125 | 36 | 39 | 49 | 12 | 20 | 3 | 8 | 2 | 37 | 107 | 37 | 7 | 9 | 237 | 939 |

## TABLE H.

*Maternal Grandsire and Offspring ♀.*

Maternal Grandsire.

| Offspring ♀. | R. | R. F. | R. or F. | R. W. | W. R. | Bd. | Bd. W. | W. Bd. | F. | F. W. | W. F. | W. | Be. W. | Be. Tk. | Be. | Bk. W. | W. Bk. | Bk. Tk. | Bk. W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 24 | 2 | 3 | 6 | — | 10 | 2 | 3 | 4 | 1 | 1 | — | 1 | 1 | — | 8 | 6 | 3 | 2 | 13 | 90 |
| R. F. ... | 3 | — | 6 | 1 | — | 1 | 3 | 1 | 1 | 4 | — | — | 1 | — | — | 4 | — | — | — | 8 | 33 |
| F. R. ... | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 3 |
| R. W. ... | 7 | 1 | — | — | — | 1 | — | 1 | — | 1 | 1 | — | — | — | — | 3 | — | — | — | 2 | 17 |
| W. R. ... | 4 | — | 1 | 1 | — | 1 | — | 1 | 3 | — | — | — | — | — | — | 1 | 4 | — | — | 1 | 17 |
| R. F. W. ... | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| W. F. R. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| Bd. ... | 30 | 1 | — | — | 3 | 36 | 11 | 5 | 12 | 2 | 2 | 1 | 1 | — | — | 10 | 5 | — | — | 51 | 170 |
| Bd. W. ... | 8 | — | — | — | — | 6 | 3 | 2 | 1 | — | 2 | — | — | — | 1 | 4 | 1 | — | — | 5 | 33 |
| W. Bd. ... | 12 | — | — | — | — | 1 | — | 3 | — | 1 | 3 | — | 1 | — | — | 6 | 4 | — | — | 5 | 36 |
| F. ... | 13 | — | — | 1 | 1 | 10 | 6 | 4 | 11 | 3 | 1 | — | — | — | 3 | 2 | — | 2 | — | 22 | 79 |
| F. W. ... | 2 | — | — | 2 | — | 5 | 1 | 2 | 6 | 1 | 1 | — | — | 1 | 2 | 3 | — | — | — | 8 | 34 |
| W. F. ... | 5 | — | — | — | — | 2 | 2 | — | 2 | — | — | — | — | — | 2 | 3 | — | — | — | 5 | 21 |
| W. ... | 2 | — | — | — | — | 2 | — | 1 | 2 | — | 1 | — | — | — | — | 2 | — | — | 1 | 4 | 15 |
| Be. W. ... | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | 3 | — | — | — | 1 | 5 |
| W. Be. ... | — | — | — | — | — | 1 | — | — | — | — | — | — | — | 1 | 2 | 2 | — | — | — | 1 | 7 |
| Be. ... | 3 | — | — | — | — | — | — | 3 | 1 | 1 | — | — | — | 1 | 2 | 2 | — | — | 1 | 13 | 27 |
| Bk. W. ... | 7 | — | — | — | — | 7 | 4 | 1 | 1 | — | 1 | — | — | — | 1 | 13 | 2 | — | — | 14 | 51 |
| W. Bk. ... | 2 | — | — | — | — | 7 | 3 | 1 | 1 | — | — | — | 2 | — | 2 | 2 | 5 | — | — | 13 | 38 |
| Bk. Tk. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 2 |
| W. Bk. Tk. | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. Tk. ... | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bk. ... | 25 | — | — | 9 | 2 | 18 | 6 | 5 | 5 | 1 | 3 | 2 | 2 | — | 13 | 33 | 8 | 3 | 5 | 65 | 205 |
| Totals | 149 | 4 | 10 | 20 | 6 | 109 | 44 | 33 | 52 | 15 | 16 | 3 | 8 | 4 | 28 | 101 | 35 | 8 | 10 | 233 | 888 |

## TABLE I.

*Paternal Grandam and Offspring ♂.*

Paternal Grandam.

| Offspring ♂. | R. | R. F. | R. or F. | F. or R. | R. W. | W. R. | R. or F. W. | W. R. or F. | Bd. | Bd. W. | W. Bd. | Bd. F. | F. | F. W. | W. F. | W. | Be. | Bk. W. | W. Bk. | Bk. W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 26 | 1 | — | — | 8 | 1 | 1 | — | 11 | 4 | 5 | — | 2 | — | 3 | — | 5 | 6 | 6 | — | 16 | 95 |
| R. F. ... | 9 | — | — | — | 1 | — | — | — | 3 | — | 1 | 1 | — | — | 2 | — | — | 3 | 1 | 1 | 5 | 27 |
| R. W. ... | 4 | — | — | 1 | 2 | 1 | — | — | 6 | 1 | 2 | — | 1 | — | 1 | — | — | 1 | — | — | 2 | 22 |
| W. R. ... | 3 | — | — | — | 2 | — | — | — | 7 | 1 | 4 | — | — | — | 2 | — | — | — | 1 | — | 1 | 21 |
| R. F. W. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 2 | — | — | — | 3 |
| F. R. W. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| W. R. F. ... | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bd. ... | 26 | 2 | — | — | 3 | 1 | — | — | 28 | 27 | 16 | — | 8 | — | 5 | — | 2 | 18 | 1 | — | 22 | 159 |
| Bd. W. ... | 7 | — | — | — | 2 | — | — | — | 13 | 5 | 3 | — | — | — | 3 | — | 1 | 2 | 1 | — | 4 | 41 |
| W. Bd. ... | 7 | 1 | — | — | — | — | — | — | 10 | 4 | 4 | 3 | — | 1 | 1 | — | — | 3 | 2 | — | 7 | 43 |
| F. Bd. ... | — | — | — | — | — | — | — | — | 1 | — | 1 | — | — | — | 1 | — | — | — | — | — | — | 3 |
| Bd. F. ... | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| R. Bd. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| R. Bd. W. | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 1 |
| F. ... | 19 | — | — | 2 | 5 | — | — | — | 8 | 2 | 2 | — | 13 | — | 3 | 5 | 4 | 6 | 7 | 1 | 12 | 89 |
| F. W. ... | 5 | — | — | — | 2 | — | — | — | 7 | 1 | 1 | — | 2 | 2 | 1 | 1 | — | 2 | — | — | 2 | 26 |
| W. F. ... | 4 | — | — | 1 | 1 | — | — | — | 2 | — | 1 | — | — | — | — | 1 | 1 | 4 | — | — | 6 | 21 |
| W. ... | 2 | — | — | — | — | — | — | — | 2 | — | 1 | — | — | — | — | — | — | 3 | — | — | 3 | 11 |
| Be. W. ... | — | — | — | — | — | — | — | — | — | — | 1 | — | 2 | 1 | 1 | — | 2 | 2 | — | — | 1 | 10 |
| W. Be. ... | 1 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 4 | — | — | 1 | 7 |
| Be. Bd. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 |
| W. Be. Bd. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 |
| Be. F. ... | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Be. ... | 4 | — | 3 | — | — | 1 | — | 1 | 5 | 3 | 1 | — | — | 1 | 2 | — | 2 | 4 | — | — | 6 | 33 |
| Bk. W. ... | 7 | — | — | — | 2 | 1 | 1 | — | 13 | 2 | 10 | — | 4 | 5 | 1 | 1 | 1 | 8 | 10 | 2 | 10 | 78 |
| W. Bk. ... | 5 | — | — | — | 1 | — | — | — | 8 | 6 | 2 | — | 2 | 1 | — | 2 | — | 3 | 6 | — | 4 | 40 |
| Bk. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 |
| W. Tk. ... | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 1 |
| Bk. ... | 29 | 4 | 1 | — | 5 | 1 | 3 | 1 | 30 | 18 | 12 | — | 8 | 3 | 3 | — | 2 | 30 | 23 | 2 | 33 | 208 |
| Totals | 158 | 8 | 4 | 4 | 35 | 6 | 5 | 2 | 156 | 75 | 69 | 4 | 42 | 14 | 29 | 10 | 21 | 104 | 58 | 6 | 137 | 947 |

## TABLE J.

*Paternal Grandam and Offspring* ♀.

Paternal Grandam.

| Offspring ♀. | R. | R. F. | R. or F. | F. or R. | R. W. | W. R. | R. or F. W. | W. R. or F. | Bd. | Bd. W. | W. Bd. | Bd. F. | F. | F. W. | W. F. | W. | Be. | Bk. W. Tk. | W. Bk. | Bk. W. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 19 | — | — | — | 9 | — | 1 | 2 | 11 | 2 | 5 | — | 3 | — | 3 | 2 | 5 | 4 | 3 | 1 | 20 | 90 |
| R. F. ... | 8 | — | — | — | 5 | — | — | — | 3 | 1 | 1 | — | 1 | — | 2 | — | — | 5 | 1 | — | 7 | 34 |
| F. R. ... | 3 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 |
| R. W. ... | 3 | — | — | 1 | 2 | — | — | — | 2 | — | — | — | 2 | — | 1 | — | — | 4 | 1 | — | 1 | 17 |
| W. R. ... | 5 | 1 | — | — | — | — | — | — | 5 | — | 3 | — | 1 | — | — | — | — | — | 2 | — | 1 | 18 |
| R. F. W.... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | 2 |
| W. F. R.... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bd. ... | 32 | 1 | — | — | 4 | — | — | — | 27 | 23 | 18 | — | 10 | 1 | 3 | — | — | 15 | 11 | — | 27 | 172 |
| Bd. W. ... | 7 | — | — | — | 1 | 1 | — | — | 10 | 3 | 7 | — | 1 | — | 2 | — | — | 2 | 1 | — | 3 | 38 |
| W. Bd. ... | — | 1 | — | — | 1 | — | — | — | 10 | 7 | 8 | — | 1 | 1 | 1 | — | — | 3 | — | — | 4 | 37 |
| F. ... | 19 | — | — | — | 2 | — | 1 | — | 10 | 4 | 3 | — | 9 | — | 2 | 2 | 5 | 5 | 1 | — | 14 | 77 |
| F. W. ... | 2 | — | — | — | 3 | 2 | — | — | 9 | 3 | 1 | 1 | 1 | 1 | 2 | — | 1 | 5 | 2 | — | 2 | 35 |
| W. F. ... | 1 | — | — | 2 | — | — | — | — | 4 | 1 | 1 | — | — | 1 | 2 | — | 2 | 2 | — | — | 7 | 23 |
| W. ... | 3 | — | — | — | — | — | — | — | 4 | — | 2 | — | — | 2 | 2 | — | 1 | — | — | — | 2 | 16 |
| Be. W. ... | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 3 | 5 |
| W. Be. ... | — | — | — | — | — | — | — | — | 2 | — | — | — | 2 | — | — | — | — | 2 | — | — | 1 | 7 |
| Be. ... | 6 | — | 1 | — | — | 1 | — | — | 2 | 5 | — | — | — | 1 | 2 | — | 2 | 3 | — | — | 2 | 25 |
| Bk. W. ... | 6 | 1 | 1 | — | 1 | — | 2 | — | 9 | 3 | — | — | 1 | 5 | — | 1 | 2 | 6 | 8 | 1 | 6 | 53 |
| W. Bk. ... | 5 | — | — | — | 2 | — | — | — | 12 | 3 | — | — | — | 1 | — | — | — | 6 | 4 | — | 5 | 38 |
| Bk. Tk. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | 2 |
| W. Bk. Tk. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| W. Tk. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bk. ... | 37 | — | 1 | — | 7 | — | 2 | 2 | 21 | 18 | 9 | — | 12 | 2 | 6 | 3 | — | 30 | 20 | 2 | 33 | 205 |
| Totals | 159 | 4 | 3 | 3 | 37 | 5 | 6 | 4 | 141 | 73 | 58 | 1 | 44 | 15 | 29 | 8 | 18 | 92 | 55 | 4 | 141 | 900 |

## TABLE K.

*Maternal Grandam and Offspring ♂.*

Maternal Grandam.

| Offspring ♂ | R. | R. F. | F. R. | R. W. | W. R. | W. R. or F. | Bd. | Bd. W. | W. Bd. | F. | F. W. | W. F. | W. | Be. W. | Be. | Bk. W. | W. Bk. | Bk. Tk. | Bk. W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 12 | 5 | — | 4 | 3 | 5 | 11 | 4 | — | 3 | 1 | 1 | — | — | — | 18 | 7 | 1 | 3 | 16 | 94 |
| R. F. ... | 2 | 1 | — | 1 | 1 | 2 | 4 | 1 | — | 5 | — | — | — | 1 | 2 | 2 | — | 1 | — | 4 | 27 |
| F. R. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 2 |
| R. W. ... | 1 | 1 | — | — | 3 | — | — | 1 | 1 | 2 | — | — | 1 | — | 1 | 5 | — | 1 | — | 4 | 21 |
| W. R. ... | 5 | — | — | — | 1 | 2 | 2 | 1 | — | 2 | 1 | — | — | — | — | 2 | 2 | — | — | 3 | 21 |
| R. F. W. ... | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 3 |
| F. R. W. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 |
| W. R. F. | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bd. ... | 22 | 3 | 1 | 3 | — | 1 | 20 | 4 | 5 | 16 | — | 6 | 1 | — | 5 | 19 | 4 | 1 | 1 | 37 | 149 |
| Bd. W. ... | 4 | — | 1 | 1 | — | — | 6 | 6 | 1 | 1 | — | 1 | 1 | — | — | 5 | 4 | — | — | 9 | 40 |
| W. Bd. ... | 1 | — | — | 1 | — | — | 7 | 8 | 8 | 4 | 1 | 6 | — | — | — | 2 | 3 | — | — | 3 | 44 |
| F. Bd. ... | — | — | — | — | — | — | — | — | — | 2 | — | — | — | — | 1 | — | — | — | — | — | 3 |
| Bd. F. ... | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| R. Bd. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 |
| R. Bd. W. | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| F. ... | 11 | 10 | — | 3 | — | — | 8 | 2 | 2 | 11 | — | 3 | — | 1 | — | 22 | 3 | 1 | — | 8 | 85 |
| F. W. ... | 7 | 2 | — | 1 | 1 | — | — | 1 | 1 | 1 | 1 | 1 | — | 1 | — | 3 | 1 | — | — | 4 | 25 |
| W. F. ... | 1 | 1 | — | 3 | 1 | — | 2 | — | — | 2 | 1 | 1 | — | — | — | 3 | 1 | — | — | 4 | 20 |
| W. ... | 2 | — | — | — | — | — | 2 | — | 2 | — | — | 2 | — | — | — | — | 1 | — | — | 1 | 10 |
| Be. W. ... | — | — | — | — | 1 | — | 1 | — | — | — | 1 | — | — | — | — | 5 | 1 | — | — | 1 | 10 |
| W. Be. ... | 1 | — | — | — | 1 | — | — | — | 2 | — | — | — | — | — | 2 | — | — | — | — | 1 | 7 |
| Be. Bd. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. Be. Bd. | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Be. F. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Be. ... | 3 | — | — | 1 | — | — | 3 | — | 1 | 2 | 1 | — | — | 3 | 4 | 3 | — | 1 | — | 8 | 30 |
| Bk. W. ... | 9 | — | — | 1 | 4 | — | 9 | 1 | 3 | 5 | 4 | 1 | — | 1 | 2 | 17 | 6 | 2 | — | 15 | 80 |
| W. Bk. ... | 3 | — | — | 1 | 3 | — | 4 | — | 1 | 3 | — | 1 | — | — | — | 5 | 5 | 1 | — | 8 | 35 |
| Bk. Tk. ... | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| Bk. ... | 23 | 2 | — | 1 | 6 | — | 17 | 6 | 2 | 12 | 3 | 6 | 6 | 1 | 6 | 29 | 13 | 2 | 2 | 58 | 195 |
| Totals | 109 | 25 | 2 | 21 | 25 | 10 | 102 | 36 | 30 | 71 | 14 | 29 | 9 | 8 | 23 | 142 | 52 | 11 | 6 | 186 | 911 |

## TABLE L.

*Maternal Grandam and Offspring ♀.*

Maternal Grandam.

| Offspring ♀. | R. | R. F. | F. R. | R. W. | W. R. | W. R. or F. | Bd. | Bd. W. | W. Bd. | F. | F. W. | W. F. | W. | Be. W. | Be. | Bk. W. | W. Bk. | Bk. Tk. | Bk. W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 8 | 1 | — | 2 | 2 | 2 | 15 | 6 | 1 | 4 | 1 | — | — | — | 2 | 19 | 5 | — | 3 | 14 | 85 |
| R. F. ... | 3 | — | — | — | 2 | 2 | 7 | 3 | — | 7 | — | — | — | 1 | 1 | 3 | 1 | — | — | 3 | 33 |
| F. R. ... | 1 | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | 3 |
| R. W. ... | — | 1 | — | — | — | — | 1 | 1 | — | 1 | — | 2 | — | — | — | 7 | 1 | — | — | — | 14 |
| W. R. ... | 3 | 1 | — | — | — | 2 | 2 | 1 | 1 | 3 | — | — | — | — | — | 2 | — | — | — | 2 | 17 |
| R. F. W. ... | — | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| W. R. F. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bd. ... | 16 | 5 | 2 | 3 | 1 | 2 | 9 | 12 | 6 | 9 | 10 | 7 | 1 | — | 1 | 22 | 13 | 2 | 1 | 40 | 162 |
| Bd. W. ... | 5 | — | 1 | 1 | 1 | — | 4 | 7 | 1 | 2 | — | 1 | — | — | — | 3 | 2 | 1 | — | 8 | 37 |
| W. Bd. ... | 3 | 1 | — | 2 | — | — | 9 | 2 | 4 | 5 | 1 | 2 | — | — | — | 2 | — | — | — | 6 | 37 |
| F. ... | 8 | 5 | — | 5 | — | — | 7 | 1 | 2 | 8 | 1 | 3 | — | — | — | 12 | 6 | 3 | — | 14 | 75 |
| F. W. ... | 5 | 3 | — | 2 | — | — | — | 1 | — | 2 | — | 1 | 1 | — | 1 | 9 | 2 | 2 | — | 2 | 31 |
| W. F. ... | 2 | 2 | — | 1 | 1 | — | 1 | 1 | 2 | 2 | 2 | 1 | — | — | — | 4 | 1 | — | — | 3 | 23 |
| W. ... | — | 1 | — | — | — | — | 2 | — | 2 | 1 | — | 1 | 2 | — | — | 3 | 1 | — | — | 3 | 16 |
| Be. W. ... | — | — | — | 1 | — | — | — | — | — | 1 | — | — | — | — | — | 1 | — | — | — | 2 | 5 |
| W. Be. ... | 2 | — | — | — | 1 | — | — | — | — | 2 | — | — | — | — | 1 | — | — | — | — | 1 | 7 |
| Be. ... | 2 | — | — | 1 | 1 | — | 1 | — | — | — | 1 | — | — | 2 | 4 | 5 | 1 | 1 | — | 7 | 26 |
| Bk. W. ... | 8 | — | — | 3 | 3 | — | 3 | — | — | 4 | — | 1 | 1 | 1 | 1 | 8 | 4 | 1 | 1 | 10 | 49 |
| W. Bk. ... | 2 | — | — | — | 1 | — | 2 | — | 4 | 1 | 1 | 2 | — | — | — | 5 | 6 | — | — | 14 | 38 |
| Bk. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 | 2 |
| W. Bk. Tk. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 |
| W. Tk. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bk. ... | 27 | — | — | 3 | 2 | — | 13 | 2 | 2 | 9 | 2 | 6 | 5 | 2 | 8 | 40 | 18 | — | 2 | 57 | 198 |
| Totals | 96 | 20 | 3 | 24 | 15 | 8 | 77 | 41 | 25 | 61 | 19 | 27 | 10 | 6 | 19 | 146 | 62 | 10 | 7 | 187 | 863 |

## TABLE M.

*Brother and Brother.*

First Brother.

| Second Brother. | R. | R. F. | R. or F. | R. W. | R. F. W. | R. or F. W. | Bd. | Bd. W. | F. Bd. | F. | F. W. | Bd. F. W. | W. | Be. W. | Be. Bd. | Be. Bd. W. | Be. F. | Be. | Bk. W. | Bk. W. Tk. | W. Bk. Tk. | F. Bk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 266 | 4 | 1 | 40 | 1 | — | 47 | 16 | — | 32 | 30 | — | 9 | 2 | — | — | — | 11 | 45 | — | — | — | 114 | 618 |
| R. F. ... | 4 | 8 | 6 | — | — | — | — | 1 | — | 4 | — | — | — | — | — | — | — | 2 | 1 | — | — | — | 5 | 31 |
| R. or F. ... | 1 | 6 | 52 | — | — | — | 8 | — | — | — | — | — | — | — | — | — | — | 1 | 3 | — | — | — | 1 | 72 |
| R. W. ... | 40 | — | — | 128 | — | — | 11 | 13 | — | 7 | 14 | — | 2 | 1 | — | — | — | — | 37 | — | — | — | 15 | 268 |
| R. F. W. ... | 1 | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 3 |
| R. or F. W. | — | — | — | — | — | — | 1 | 2 | — | — | 4 | — | — | — | — | — | — | — | — | — | — | — | — | 7 |
| Bd. ... | 47 | — | 8 | 11 | — | 1 | 350 | 92 | 2 | 66 | 27 | — | 4 | 7 | 3 | — | — | 20 | 43 | — | 2 | 1 | 160 | 844 |
| Bd. W. ... | 16 | 1 | — | 13 | 1 | 2 | 92 | 216 | 2 | 16 | 39 | 2 | 5 | 8 | — | 1 | — | 2 | 92 | — | 2 | — | 26 | 536 |
| F. Bd. ... | — | — | — | — | — | — | 2 | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 5 |
| F. ... | 32 | 4 | — | 7 | — | — | 66 | 16 | — | 206 | 48 | — | 6 | 4 | 1 | — | — | 28 | 36 | — | — | — | 108 | 562 |
| F. W. ... | 30 | — | — | 14 | — | 4 | 27 | 39 | — | 48 | 182 | — | 13 | 13 | — | — | — | 5 | 108 | — | — | — | 46 | 529 |
| Bd. F. W. | — | — | — | — | — | — | — | 2 | — | — | — | 2 | — | 4 | — | — | — | — | 5 | — | — | — | — | 13 |
| W. ... | 9 | — | — | 2 | — | — | 4 | 5 | — | 6 | 13 | — | 18 | 2 | — | 2 | — | 3 | 21 | — | 1 | — | 3 | 89 |
| Be. W. ... | 2 | — | — | 1 | — | — | 7 | 8 | — | 4 | 13 | 4 | 2 | 36 | — | — | — | 18 | 47 | — | — | — | 15 | 157 |
| Be. Bd. ... | — | — | — | — | — | — | 3 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 4 |
| Be. Bd. W. | — | — | — | — | — | — | — | 1 | — | — | — | — | 2 | — | — | — | — | — | 1 | — | — | — | — | 4 |
| Be. F. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 | 2 |
| Be. ... | 11 | 2 | 1 | — | — | — | 20 | 2 | — | 28 | 5 | — | 3 | 18 | — | — | — | 92 | 24 | — | — | — | 115 | 321 |
| Bk. W. ... | 45 | 1 | 3 | 37 | — | — | 43 | 92 | — | 36 | 108 | 5 | 21 | 47 | — | 1 | 1 | 24 | 924 | 3 | 3 | — | 207 | 1601 |
| Bk. W. Tk. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 | — | — | — | — | 3 |
| W. Bk. Tk. | — | — | — | — | — | — | 2 | 2 | — | — | — | — | 1 | — | — | — | — | — | 3 | — | — | — | 2 | 10 |
| F. Bk. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 30 | — | 31 |
| Bk. ... | 114 | 5 | 1 | 15 | 1 | — | 160 | 26 | 1 | 108 | 46 | — | 3 | 15 | — | — | 1 | 115 | 207 | — | 2 | — | 954 | 1774 |
| Totals | 618 | 31 | 72 | 268 | 3 | 7 | 844 | 536 | 5 | 562 | 529 | 13 | 89 | 157 | 4 | 4 | 2 | 321 | 1601 | 3 | 10 | 31 | 1774 | 7484 |

## TABLE N.

*Sister and Sister.*

First Sister.

Second Sister.

| | R. | R. F. | R. or F. | R. W. | R. F. W. | R. or F. W. | Bd. | Bd. W. | F. Bd. | R. or Bd. | R. Tk. Bk. | F. | F. W. | Bd. F. W. | Bd. or F. W. | W. | Be. W. | Be. Bd. | Be. F. | Be. | Be. Bk. W. | Bk. W. | F. Bk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 346 | 5 | — | 45 | — | 1 | 39 | 3 | — | — | — | 27 | 22 | — | — | 2 | 3 | — | 1 | 3 | — | 41 | — | 104 | 642 |
| R. F. ... | 5 | 14 | — | 2 | 1 | — | 5 | 3 | — | — | — | 4 | 1 | — | — | — | 1 | — | — | — | — | 5 | — | 3 | 44 |
| R. or F. ... | — | — | 40 | — | — | — | 13 | 1 | — | — | — | 4 | 1 | — | — | 1 | — | — | — | — | — | 1 | — | 13 | 74 |
| R. W. ... | 45 | 2 | — | 44 | 2 | 1 | 4 | 10 | — | — | — | 6 | 1 | — | — | 14 | 3 | — | — | — | — | 20 | — | 11 | 163 |
| R. F. W.... | — | 1 | — | 2 | 4 | — | — | 6 | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 2 | — | 1 | 17 |
| R. or F. W. | 1 | — | — | 1 | — | — | 1 | — | — | — | — | 1 | 2 | 1 | — | — | — | — | — | — | — | 2 | — | — | 9 |
| Bd. ... | 39 | 5 | 13 | 4 | — | 1 | 442 | 66 | 2 | — | — | 58 | 13 | 1 | — | 12 | 7 | 3 | — | 23 | — | 42 | 2 | 91 | 824 |
| Bd. W. ... | 3 | 3 | 1 | 10 | 6 | — | 66 | 154 | 1 | — | — | 6 | 32 | 1 | 1 | 10 | 11 | — | — | 2 | — | 91 | 2 | 25 | 425 |
| F. Bd. ... | — | — | — | — | — | — | 2 | 1 | — | — | — | — | — | 1 | — | — | 2 | — | — | — | — | — | — | — | 6 |
| R. or Bd.... | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| R. Tk. Bk. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| F. ... | 27 | 4 | 4 | 6 | — | 1 | 58 | 6 | — | 2 | — | 172 | 67 | 1 | — | 6 | 4 | 1 | — | 18 | — | 39 | — | 91 | 507 |
| F. W. ... | 22 | 1 | 1 | 1 | 1 | 2 | 13 | 32 | — | — | — | 67 | 146 | — | — | 3 | 15 | — | 1 | 5 | — | 83 | — | 20 | 413 |
| Bd. F. W. | — | — | — | — | — | 1 | 1 | 1 | 1 | — | — | 1 | — | — | — | — | 2 | — | — | — | — | — | — | — | 7 |
| Bd. or F. W. | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | 2 |
| W. ... | 2 | — | 1 | 14 | — | — | 12 | 10 | — | — | — | 6 | 3 | — | — | 18 | 2 | — | — | 5 | — | 13 | — | 7 | 93 |
| Be. W. ... | 3 | 1 | — | 3 | — | — | 7 | 11 | 2 | — | — | 4 | 15 | 2 | — | 2 | 30 | — | 1 | 6 | — | 47 | — | 14 | 148 |
| Be. Bd. ... | — | — | — | — | — | — | 3 | — | — | — | — | 1 | — | — | — | — | — | 6 | — | — | — | — | — | 3 | 13 |
| Be. F. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 | — | — | — | — | 1 | — | — | 4 |
| Be. ... | 3 | — | — | — | — | — | 23 | 2 | — | — | — | 18 | 5 | — | — | 5 | 6 | — | — | 104 | — | 11 | — | 90 | 267 |
| Be. Bk. W. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | 2 |
| Bk. W. ... | 41 | 5 | 1 | 20 | 2 | 2 | 42 | 91 | — | — | — | 39 | 83 | — | 1 | 13 | 47 | — | 1 | 11 | 2 | 844 | — | 114 | 1359 |
| F. Bk. ... | — | — | — | — | — | — | 2 | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 74 | — | 78 |
| Bk. ... | 104 | 3 | 13 | 11 | 1 | — | 91 | 25 | — | — | 1 | 91 | 20 | — | — | 7 | 14 | 3 | — | 90 | — | 114 | — | 854 | 1442 |
| Totals | 642 | 44 | 74 | 163 | 17 | 9 | 824 | 425 | 6 | 2 | 1 | 507 | 413 | 7 | 2 | 93 | 148 | 13 | 4 | 267 | 2 | 1359 | 78 | 1442 | 6542 |

## TABLE O.

*Brother and Sister.*

Brother.

| Sister. | R. | R. F. | R. or F. | R. W. | R. F. W. | R. or F. W. | Bd. | Bd. Bk. | Bd. W. | F. Pd. | F. | F. W. | Bd. F. W. | W. | Be. W. | Be. Bd. W. | Be. F. | Be. | Bk. W. | Bk. W. Tk. | W. Bk. Tk. | F. Bk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 253 | 5 | 1 | 62 | — | — | 54 | 2 | 5 | — | 30 | 32 | — | 9 | 4 | — | 1 | 11 | 23 | — | — | — | 96 | 588 |
| R. F. ... | 6 | 24 | 8 | 2 | — | — | 8 | — | 3 | — | 3 | — | — | — | — | — | — | 2 | 1 | — | — | — | 5 | 62 |
| R. or F. ... | 1 | — | 29 | — | — | 1 | 5 | — | 4 | — | 10 | — | — | — | — | — | — | — | 3 | — | — | — | 1 | 54 |
| R. W. ... | 50 | — | 1 | 90 | — | — | 6 | — | 11 | — | 7 | 6 | — | 1 | — | — | — | 2 | 24 | — | — | — | 13 | 211 |
| R. F. W. ... | — | 1 | — | 2 | 2 | — | — | — | 2 | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 | 9 |
| R. or F. W. | 1 | — | — | — | — | 1 | — | — | — | — | 1 | 5 | — | — | — | — | — | — | — | — | — | — | — | 8 |
| Bd. ... | 27 | 2 | 6 | 7 | — | 2 | 394 | 3 | 71 | 3 | 55 | 27 | — | 1 | 10 | 1 | — | 18 | 70 | 2 | 2 | 1 | 147 | 849 |
| Bd. W. ... | 18 | 1 | — | 16 | 1 | — | 61 | — | 210 | 2 | 13 | 33 | 2 | 4 | 2 | 2 | — | 1 | 96 | — | — | 1 | 22 | 485 |
| F. Bd. ... | — | — | — | — | — | — | — | — | 1 | — | 1 | — | 2 | — | 2 | — | — | — | 2 | — | — | — | — | 8 |
| R. or Bd. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | 1 | 4 |
| R. Tk. Bk. | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 2 |
| F. ... ... | 41 | 4 | 9 | 9 | — | 1 | 61 | — | 10 | — | 197 | 52 | — | 5 | 3 | — | — | 22 | 38 | — | — | — | 109 | 561 |
| F. W. ... | 31 | — | — | 18 | — | 1 | 17 | — | 53 | — | 49 | 165 | — | 24 | 15 | — | 1 | 8 | 82 | — | — | — | 39 | 503 |
| Bd. F. W. | — | — | — | — | — | 1 | — | — | 1 | — | — | 4 | 2 | — | 2 | — | — | — | 2 | — | — | — | — | 12 |
| Bd. or F. W. | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | 3 | — | — | — | — | 4 |
| W. ... | 5 | — | — | 3 | — | 1 | 9 | — | 11 | — | 1 | 9 | — | 16 | 5 | — | — | 2 | 14 | — | 1 | — | 15 | 92 |
| Be. W. ... | 3 | 1 | — | 7 | — | — | 2 | — | 9 | — | 6 | 13 | 5 | 5 | 35 | — | 1 | 6 | 48 | — | — | — | 15 | 156 |
| Be. Bd. ... | — | — | — | — | — | — | 8 | — | — | — | — | — | — | — | — | — | — | 8 | — | — | — | — | — | 16 |
| Be. Bd. Tk. | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 | 3 |
| Be. F. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 | — | — | — | 1 | 3 |
| Be. ... | 15 | 1 | — | 1 | — | — | 19 | — | 7 | — | 18 | 8 | — | 1 | 14 | — | — | 100 | 36 | — | — | — | 106 | 326 |
| Be. Bk. W. | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 2 |
| Bk. W. ... | 43 | — | 3 | 28 | 1 | — | 34 | — | 82 | — | 32 | 180 | — | 15 | 47 | — | 1 | 13 | 914 | 3 | 1 | — | 153 | 1550 |
| F. Bk. ... | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 56 | — | 58 |
| Bk. ... ... | 111 | 4 | 2 | 13 | 1 | — | 105 | — | 22 | — | 97 | 22 | — | 5 | 31 | — | — | 127 | 181 | — | 1 | — | 887 | 1609 |
| Totals | 606 | 44 | 59 | 258 | 5 | 8 | 787 | 5 | 503 | 5 | 520 | 556 | 11 | 86 | 170 | 3 | 5 | 321 | 1543 | 5 | 5 | 58 | 1612 | 7175 |

## TABLE MM.

*Brother and Brother.*

First Brother.

| Second Brother. | R. | R. F. | F. R. | R. W. | W. R. | R. F. W. | W. R. F. | F. R. W. | Bd. | Bd. W. | W. Bd. | F. Bd. | Bd. F. | R. Bd. | R. Bd. W. | F. | F. W. | W. F. | W. | Be. W. | W. Be. | W. Be. Bd. | Be. F. | Be. | Bk. W. | W. Bk. | Bk. Tk. | W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 24 | 4 | — | 4 | 9 | — | — | — | 7 | 3 | 2 | — | 1 | — | — | 15 | 4 | — | 1 | 2 | — | — | — | 2 | 1 | — | — | — | 22 | 101 |
| R. F. ... | 4 | 2 | — | — | — | — | — | — | 7 | — | — | 1 | — | — | — | 1 | — | 4 | — | — | — | — | — | — | 4 | — | — | — | 4 | 27 |
| F. R. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 |
| R. W. ... | 4 | — | — | 4 | 1 | — | — | — | 3 | 2 | 1 | — | — | — | — | 3 | 2 | 1 | — | — | 1 | — | — | — | — | — | — | 4 | 26 |
| W. R. ... | 9 | — | — | 1 | 2 | — | — | — | 2 | 2 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 17 |
| R. F. W. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | — | 1 | — | — | 2 | — | — | — | 5 |
| W. R. F. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 1 |
| F. R. W. ... | — | — | — | — | — | — | — | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| Bd. ... | 7 | 7 | — | 3 | 2 | — | — | 1 | 60 | 11 | 9 | 4 | — | 1 | — | 12 | 4 | — | 1 | — | — | — | 2 | 5 | 3 | 2 | — | — | 37 | 171 |
| Bd. W. ... | 3 | — | — | 2 | 2 | — | — | 1 | 11 | 2 | 7 | — | — | — | 2 | 3 | 2 | 1 | — | — | — | — | — | 1 | 2 | 1 | — | — | 5 | 45 |
| W. Bd. ... | 2 | — | — | 1 | — | — | — | — | 9 | 7 | 14 | — | — | — | — | 3 | 1 | — | 1 | — | 1 | — | — | — | 2 | 8 | — | — | 4 | 53 |
| F. Bd. ... | — | 1 | — | — | — | — | — | — | 4 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 5 |
| Bd. F. ... | 1 | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| R. Bd. ... | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 2 |
| R. Bd. W. | — | — | — | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| F. ... | 15 | 1 | — | 3 | — | — | — | — | 12 | 3 | 3 | — | — | — | — | 24 | 5 | 4 | — | 2 | — | — | — | 2 | 6 | 2 | — | — | 8 | 90 |
| F. W. ... | 4 | — | — | 2 | — | — | — | — | 4 | 2 | 1 | — | — | — | — | 5 | — | 1 | 1 | — | — | — | — | 1 | 1 | 1 | — | — | 2 | 25 |
| W. F. ... | — | 4 | — | 1 | — | — | 1 | — | — | 1 | — | — | — | — | — | 4 | 1 | 8 | 1 | — | 1 | — | — | — | 1 | 1 | — | — | 2 | 26 |
| W. ... | 1 | — | — | — | — | — | — | — | 1 | — | 1 | — | — | — | — | — | 1 | 1 | — | — | 1 | — | — | — | 3 | — | — | — | 2 | 11 |
| Be. W. ... | 2 | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | 5 | — | — | — | — | 11 |
| W. Be. ... | — | — | — | 1 | — | — | — | — | — | — | 1 | — | — | — | — | — | — | 1 | 1 | — | — | — | — | — | — | 1 | 1 | — | — | 6 |
| W. Be. Bd. | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Be. F. ... | — | — | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| Be. ... | 2 | — | 1 | — | — | — | — | — | 5 | 1 | — | — | — | — | — | 2 | 1 | — | — | — | — | — | — | 8 | 2 | — | — | — | 16 | 38 |
| Bk. W. ... | 1 | 4 | — | — | — | 2 | — | — | 3 | 2 | 2 | — | — | — | — | 6 | 1 | 1 | 3 | 5 | — | — | — | 2 | 32 | 9 | — | 2 | 20 | 95 |
| W. Bk. ... | — | — | — | — | — | — | — | — | 2 | 1 | 8 | — | — | — | — | 2 | 1 | 1 | — | — | 1 | — | — | — | 9 | 12 | — | — | 7 | 44 |
| Bk. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 1 |
| W. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | — | 2 |
| Bk. ... | 22 | 4 | — | 4 | — | — | — | — | 37 | 5 | 4 | — | — | 1 | — | 8 | 2 | 2 | 2 | — | — | — | — | 16 | 20 | 7 | — | — | 98 | 232 |
| Totals | 101 | 27 | 1 | 26 | 17 | 5 | 1 | 2 | 171 | 45 | 53 | 5 | 2 | 2 | 2 | 90 | 25 | 26 | 11 | 11 | 6 | 1 | 2 | 38 | 95 | 44 | 1 | 2 | 232 | 1044 |

TABLE NN.

*Sister and Sister.*

First Sister.

| | R. | R. F. | R. W. | W. R. | R. F. W. | W. F. R. | Bd. | Bd. W. | W. Bd. | F. | F. W. | W. F. | W. | W. R. | R. F. W. | W. F. R. | Bd. | Bd. W. | W. Bd. | F. | F. W. | W. F. | W. | Be. W. | W. Be. | Bk. W. | W. Bk. | Bk. Tk. | W. Bk. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 60 | 6 | 4 | 4 | — | — | 6 | 2 | — | 4 | 3 | 3 | — | 4 | — | — | 6 | 2 | — | 4 | 3 | 3 | — | 1 | 2 | 3 | 2 | — | — | 19 | 122 |
| R. F. ... | 6 | 12 | 2 | — | — | — | 7 | 1 | — | 3 | 1 | — | — | — | — | — | 7 | 1 | — | 3 | 2 | — | — | — | — | — | — | — | — | 8 | 40 |
| R. W. ... | 4 | 2 | — | — | — | — | 3 | 1 | — | 2 | 2 | — | — | — | — | — | 3 | — | — | 2 | 2 | — | — | — | — | — | — | — | — | — | 16 |
| W. R. ... | 4 | — | — | 4 | — | — | 3 | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 | 15 |
| R. F. W. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | 2 |
| W. F. R. ... | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 1 |
| Bd. ... | 6 | 7 | 3 | 3 | — | — | 78 | 14 | 8 | 7 | 3 | 1 | — | 6 | 8 | — | 183 | 42 | 32 | 18 | 9 | 2 | 3 | 1 | 6 | 8 | 2 | 1 | — | 39 | 183 |
| Bd. W. ... | 2 | 1 | 1 | — | — | — | 14 | 8 | 4 | 3 | 2 | 1 | — | — | — | — | 42 | 8 | 4 | 7 | 2 | 2 | 1 | — | — | 2 | 1 | — | — | 4 | 42 |
| W. Bd. ... | — | — | — | — | — | — | 8 | 4 | 4 | 1 | 2 | — | — | — | — | — | 32 | 4 | 4 | 1 | 2 | 2 | — | — | — | 1 | 1 | — | — | 5 | 32 |
| F. ... | 4 | 3 | 2 | — | — | 1 | 7 | 3 | 1 | 18 | 9 | 2 | — | 4 | — | — | 82 | 20 | 1 | 18 | 9 | 2 | 2 | — | — | 1 | — | — | — | 5 | 82 |
| F. W. ... | 3 | 1 | 2 | — | — | — | 3 | 2 | 1 | 9 | 2 | 2 | — | 3 | — | — | 35 | 2 | 1 | 9 | 2 | 2 | 1 | — | — | — | — | — | — | 2 | 35 |
| W. F. ... | 3 | 2 | 2 | — | — | — | 1 | 1 | — | 2 | 2 | 2 | — | 1 | — | — | 28 | 2 | — | 2 | 2 | 2 | 1 | — | — | — | — | — | — | 2 | 28 |
| W. ... | 3 | — | 2 | — | — | — | — | — | — | 3 | 2 | 1 | — | — | — | — | 20 | 1 | — | 3 | 2 | 2 | 1 | — | — | — | — | — | — | 2 | 20 |
| Be. W. ... | — | — | — | — | — | — | — | — | — | 2 | 1 | — | — | — | — | — | 8 | 1 | — | 2 | 1 | 2 | 1 | — | — | — | — | — | — | 2 | 8 |
| W. Be. ... | 1 | — | — | 2 | — | — | 2 | — | — | 2 | — | — | — | — | — | — | 11 | 1 | — | 2 | 2 | 1 | — | — | — | — | — | — | — | 3 | 11 |
| Be. ... | 2 | — | — | — | — | — | 6 | — | — | 4 | 3 | — | — | — | — | — | 31 | 4 | — | 4 | 3 | 1 | — | — | — | — | — | — | — | 8 | 31 |
| Bk. W. ... | 3 | — | — | 1 | — | — | 8 | 2 | 1 | 2 | — | — | — | — | — | — | 63 | 6 | 2 | 4 | 4 | 1 | — | — | — | 1 | 1 | — | — | 22 | 63 |
| W. Bk. ... | 2 | — | — | — | — | — | — | 2 | 1 | 1 | 2 | — | — | — | — | — | 35 | 10 | 1 | 6 | — | 2 | 1 | — | — | — | — | — | — | 8 | 35 |
| Bk. Tk. ... | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | 4 | — | — | — | — | — | — | — | — | — | — | — | — | 4 | 4 |
| W. Bk. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 2 |
| Bk. ... | 19 | 8 | — | 1 | — | — | 39 | 4 | 5 | 20 | 2 | 2 | 2 | 3 | 8 | 22 | 8 | 4 | 1 | 88 | 2 | 2 | 2 | 3 | 8 | 22 | 8 | 4 | 1 | 238 | 238 |
| Totals | 122 | 40 | 16 | 15 | 2 | 1 | 183 | 42 | 32 | 82 | 35 | 28 | 20 | 8 | 11 | 31 | 63 | 35 | 4 | 238 | 35 | 28 | 20 | 8 | 11 | 31 | 63 | 35 | 4 | 238 | 1010 |

Second Sister.

## TABLE OO.

*Brother and Sister.*

| Sister. | Brother. R. | R. F. | F. R. | R. W. | W. R. | R. F. W. | W. R. F. | Bd. | Bd. W. | W. Bd. | F. Bd. | Bd. F. | F. | F. W. | W. F. | W. | Be. W. | W. Be. | Be. | Bk. W. | W. Bk. | W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 39 | 1 | — | 6 | 6 | — | — | 5 | 2 | 2 | 1 | — | 15 | 2 | 1 | 1 | 1 | 2 | 4 | 5 | 3 | — | 22 | 118 |
| R. F. ... | 6 | 8 | 1 | — | — | — | 1 | 5 | — | 2 | — | — | 4 | 2 | 2 | — | — | — | — | 2 | — | — | 9 | 42 |
| F. R. ... | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | 4 |
| R. W. ... | 6 | — | — | 2 | — | — | — | 2 | 2 | — | — | — | 2 | — | 2 | — | — | — | — | — | — | — | 1 | 17 |
| W. R. ... | 5 | — | — | 2 | 3 | — | — | — | 1 | — | — | — | — | 1 | — | — | — | — | — | 2 | — | — | 2 | 16 |
| Bd. ... | 9 | 5 | — | 1 | 5 | — | — | 77 | 9 | 13 | 1 | 1 | 9 | 4 | 2 | 2 | 1 | — | 6 | 7 | 1 | — | 29 | 182 |
| Bd. W. ... | 5 | — | — | 1 | 1 | — | — | 8 | 7 | 3 | — | — | 2 | 1 | — | — | 1 | — | — | 8 | 1 | 1 | 5 | 44 |
| W. Bd. ... | — | — | — | 1 | 1 | — | — | 10 | 5 | 8 | 1 | — | 3 | — | — | — | — | — | — | 5 | 5 | — | 4 | 43 |
| F. ... | 11 | 6 | — | 1 | — | — | — | 10 | 6 | 1 | — | — | 16 | 4 | 4 | — | 3 | 2 | 1 | 5 | — | — | 8 | 78 |
| F. W. ... | 5 | 3 | — | 2 | — | 1 | — | 2 | 3 | 3 | 1 | — | 7 | 2 | 1 | 1 | 2 | 2 | — | 1 | 1 | — | 6 | 43 |
| W. F. ... | 2 | — | — | 2 | — | — | — | — | 2 | 1 | — | — | 3 | 1 | 4 | 1 | 2 | — | — | 3 | 1 | — | 3 | 25 |
| W. ... | 1 | — | — | 3 | 2 | — | — | — | — | 3 | — | — | — | — | 1 | 1 | — | — | — | 3 | — | — | 2 | 16 |
| Be. W. ... | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 | — | — | 3 | 7 |
| W. Be. ... | — | — | — | — | — | — | — | 2 | — | 1 | — | — | — | — | 1 | — | — | — | 1 | 3 | 1 | — | — | 9 |
| Be. ... | 2 | — | — | 1 | — | — | — | 4 | 2 | — | — | — | — | — | — | — | — | 1 | 8 | 7 | — | — | 6 | 31 |
| Bk. W. ... | 1 | 1 | — | — | — | 2 | — | 7 | 3 | 4 | — | — | 7 | 3 | 1 | — | 2 | — | 1 | 15 | 5 | — | 28 | 80 |
| W. Bk. ... | 3 | — | — | — | 3 | — | — | 2 | 1 | 5 | — | — | 2 | — | 1 | 2 | — | — | — | 8 | 8 | — | 9 | 44 |
| Bk. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | 3 | 4 |
| W. Bk. Tk. | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 2 |
| W. Tk. ... | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bk. ... | 12 | 2 | — | — | 1 | — | — | 31 | 6 | 3 | 1 | — | 15 | 5 | 2 | 1 | 1 | 1 | 10 | 28 | 13 | — | 93 | 225 |
| Totals | 109 | 28 | 3 | 22 | 22 | 3 | 1 | 165 | 49 | 49 | 5 | 1 | 85 | 25 | 23 | 9 | 13 | 8 | 32 | 104 | 39 | 1 | 235 | 1031 |

## TABLE MMM.

*Brother and Brother.*

First Brother.

| Second Brother. | R. | R. F. | F. R. | R. W. | W. R. | R. F. W. | F. R. W. | W. R. F. | Bd. | Bk. Bd. | Bd. W. | W. Bd. | F. Bd. | R. Bd. | R. Bd. W. | F. | F. W. | W. F. | W. | Be. W. | W. Be. | Be. Bd. | Be. | Bk. W. | W. Bk. | Bk. Tk. | W. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 36 | 4 | 1 | 12 | 4 | — | — | — | 13 | — | 6 | 2 | — | 1 | — | 16 | 5 | 5 | — | — | — | — | 4 | 12 | — | — | — | 37 | 158 |
| R. F. ... | 4 | 16 | 1 | — | 1 | — | — | 1 | 13 | — | — | 2 | — | — | — | 2 | 1 | 2 | — | — | — | — | 2 | 3 | — | — | — | 8 | 56 |
| F. R. ... | 1 | 1 | — | 2 | — | — | — | — | — | — | — | 1 | — | — | — | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | 7 |
| R. W. ... | 12 | — | 2 | 2 | 2 | — | — | — | 4 | 1 | 5 | 1 | — | 1 | — | 3 | 2 | 1 | — | — | — | — | — | 6 | — | — | — | 1 | 43 |
| W. R. ... | 4 | 1 | — | 2 | 6 | — | — | — | 1 | — | — | 1 | — | — | — | 1 | 1 | — | 1 | 1 | — | — | — | — | 1 | — | — | 1 | 21 |
| R. F. W. ... | — | — | — | — | — | — | — | — | 3 | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 4 |
| F. R. W. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. R. F. ... | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Bd. ... | 13 | 13 | — | 4 | 1 | 3 | — | — | 166 | — | 17 | 14 | 1 | 1 | 1 | 16 | 6 | 2 | 3 | 4 | — | — | 8 | 14 | 7 | — | — | 55 | 349 |
| Bk. Bd. ... | — | — | — | 1 | — | — | — | — | — | — | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 |
| Bd. W. ... | 6 | — | — | 5 | — | — | — | — | 17 | 1 | 36 | 5 | — | 1 | — | 6 | 10 | 6 | 4 | 2 | — | — | 2 | 11 | 3 | — | — | 9 | 124 |
| W. Bd. ... | 2 | 2 | 1 | 1 | 1 | — | — | — | 14 | — | 5 | 10 | 1 | — | — | 2 | — | 4 | 3 | 1 | 1 | — | 3 | 8 | 7 | — | — | 5 | 71 |
| F. Bd. ... | — | — | — | — | — | — | — | — | 1 | — | — | 1 | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 1 | 4 |
| R. Bd. ... | 1 | — | — | 1 | — | — | — | — | 1 | 1 | 1 | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 | 7 |
| R. Bd. W. | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| F. ... | 16 | 2 | 1 | 3 | 1 | 1 | 1 | — | 16 | — | 6 | 2 | — | 1 | — | 36 | 5 | 7 | 2 | 4 | — | — | 4 | 7 | 3 | — | — | 25 | 143 |
| F. W. ... | 5 | 1 | — | 2 | 1 | — | — | — | 6 | — | 10 | — | 1 | — | — | 5 | 6 | 1 | — | 4 | — | — | 1 | 12 | 3 | — | — | 9 | 67 |
| W. F. ... | 5 | 2 | 1 | 1 | — | — | — | — | 2 | — | 6 | 4 | — | — | — | 7 | 1 | 10 | — | 1 | 1 | — | 2 | 2 | 3 | — | — | 3 | 51 |
| W. ... | — | — | — | — | 1 | — | — | — | 3 | — | 4 | 3 | — | — | — | 2 | — | — | 2 | 2 | — | — | 2 | 7 | 4 | 1 | — | 1 | 32 |
| Be. W. ... | — | — | — | — | 1 | — | — | — | 4 | — | 2 | 1 | — | — | — | 4 | 4 | 1 | 2 | 4 | 1 | — | 2 | 9 | 3 | — | — | 2 | 40 |
| W. Be. ... | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 1 | — | 1 | 2 | — | — | — | 1 | — | — | — | 6 |
| Be. Bd. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 |
| Be. ... | 4 | 2 | — | — | — | — | — | — | 8 | — | 2 | 3 | — | — | — | 4 | 1 | 2 | 2 | 2 | — | — | 28 | 7 | 2 | — | — | 21 | 88 |
| Bk. W. ... | 12 | 3 | — | 6 | — | — | — | — | 14 | — | 11 | 8 | — | — | — | 7 | 12 | 2 | 7 | 9 | — | — | 7 | 54 | 17 | — | 1 | 59 | 229 |
| W. Bk. ... | — | — | — | — | 1 | — | — | — | 7 | — | 3 | 7 | — | — | — | 3 | 3 | 3 | 4 | 3 | 1 | — | 2 | 17 | 42 | — | — | 37 | 133 |
| Bk. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | 6 | — | — | 7 |
| W. Tk. ... | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 |
| Bk. ... | 37 | 8 | — | 1 | 1 | — | — | — | 55 | — | 9 | 5 | 1 | 1 | — | 25 | 9 | 3 | 1 | 2 | — | 1 | 21 | 59 | 37 | — | — | 220 | 496 |
| Totals | 158 | 56 | 7 | 43 | 21 | 4 | 1 | 1 | 349 | 3 | 124 | 71 | 4 | 7 | 1 | 143 | 67 | 51 | 32 | 40 | 6 | 1 | 88 | 229 | 133 | 7 | 1 | 496 | 2144 |

## TABLE NNN.

*Sister and Sister.*

First Sister.

| Second Sister. | R. | R. F. | F. R. | R. W. | W. R. | R. F. W. | Bd. | Bk. Bd. | Bd. W. | W. Bd. | F. Bd. | R. Bd. | F. | F. W. | W. F. | W. | Be. W. | W. Be. | Be. | Bk. W. | W. Bk. | Bk. Tk. | W. Bk. Tk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. ... | 52 | 5 | 1 | 6 | 3 | — | 15 | — | 6 | 3 | — | — | 7 | 4 | 3 | 1 | — | — | 1 | 2 | 2 | — | — | 19 | 130 |
| R. F. ... | 5 | 8 | — | — | — | — | 7 | — | 2 | 1 | — | — | 7 | — | 2 | — | — | — | — | 2 | — | — | — | 11 | 45 |
| F. R. ... | 1 | — | 4 | — | — | — | 1 | — | — | — | — | — | 1 | — | — | — | — | — | 1 | 1 | — | — | — | — | 9 |
| R. W. ... | 6 | — | — | 2 | — | — | 2 | 1 | 3 | — | — | 1 | 6 | 1 | — | 1 | — | — | — | 3 | — | — | — | 4 | 30 |
| W. R. ... | 3 | — | — | — | 4 | — | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 1 | — | — | 3 | 13 |
| R. F. W. ... | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| Bd. ... | 15 | 7 | 1 | 2 | 1 | — | 184 | — | 14 | 10 | 2 | — | 22 | 8 | 6 | 4 | 1 | 1 | 11 | 12 | 13 | 1 | — | 62 | 377 |
| Bk. Bd. ... | — | — | — | 1 | — | — | — | — | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 3 |
| Bd. W. ... | 6 | 2 | — | 3 | — | — | 14 | 1 | 38 | 13 | — | 1 | 6 | 3 | 3 | 1 | 1 | 1 | 2 | 7 | 3 | — | — | 10 | 115 |
| W. Bd. ... | 3 | 1 | — | — | 1 | — | 10 | — | 13 | 22 | — | 1 | 4 | 1 | 4 | 2 | — | 2 | — | 4 | 8 | — | — | 4 | 80 |
| F. Bd. ... | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 3 |
| R. Bd. ... | — | — | — | 1 | — | — | — | 1 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 4 |
| F. ... | 7 | 7 | 1 | 6 | — | — | 22 | — | 6 | 4 | — | — | 34 | 11 | 1 | 2 | 1 | 1 | 6 | 9 | 2 | — | — | 22 | 142 |
| F. W. ... | 4 | — | — | 1 | — | — | 8 | — | 3 | 1 | — | — | 11 | 24 | 9 | — | 2 | — | 1 | 11 | — | — | — | 13 | 88 |
| W. F. ... | 3 | 2 | — | — | — | — | 6 | — | 3 | 4 | — | — | 1 | 9 | 12 | 2 | — | 2 | 2 | — | 5 | — | — | 4 | 55 |
| W. ... | 1 | — | — | 1 | — | — | 4 | — | 1 | 2 | 1 | — | 2 | — | 2 | 6 | — | — | — | — | 5 | — | — | 2 | 27 |
| Be. W. ... | — | — | — | — | — | — | 1 | — | 1 | — | — | — | 1 | 2 | — | — | 2 | — | 1 | 5 | 1 | — | — | 2 | 16 |
| W. Be. ... | — | — | — | — | — | — | 1 | — | 1 | 2 | — | — | 1 | — | 2 | — | — | 2 | 4 | — | 1 | — | — | 4 | 18 |
| Be. ... | 1 | — | 1 | — | — | — | 11 | — | 2 | — | — | — | 6 | 1 | 2 | — | 1 | 4 | 16 | 5 | 1 | — | — | 24 | 75 |
| Bk. W. ... | 2 | 2 | 1 | 3 | — | — | 12 | — | 7 | 4 | — | — | 9 | 11 | — | — | 5 | — | 5 | 54 | 8 | 1 | — | 31 | 155 |
| W. Bk. ... | 2 | — | — | — | 1 | — | 13 | — | 3 | 8 | — | — | 2 | — | 5 | 5 | 1 | 1 | 1 | 8 | 38 | — | 1 | 22 | 111 |
| Bk. Tk. ... | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 | 3 |
| W. Bk. Tk. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 |
| Bk. ... | 19 | 11 | — | 4 | 3 | — | 62 | — | 10 | 4 | — | — | 22 | 13 | 4 | 2 | 2 | 4 | 24 | 31 | 22 | 1 | — | 262 | 500 |
| Totals | 130 | 45 | 9 | 30 | 13 | 2 | 377 | 3 | 115 | 80 | 3 | 4 | 142 | 88 | 55 | 27 | 16 | 18 | 75 | 155 | 111 | 3 | 1 | 500 | 2002 |

TABLE OOO.

*Brothers and Sisters.*

| | | Brothers. | | |

TABLE MMMM.

*Brother and Brother.*

First Brother.

Second Brother.

| | R. | R. F. | R. or F. | F. R. | R. W. | W. R. | F. R. W. | W. R. or F. | Bd. | Bd. W. | W. Bd. | F. Bd. | F. | F. W. | W. F. | F. Bd. W. | W. | Be. | W. Be. | Be. Bd. W. | Be. | Bk. W. | W. Bk. | Bk. Tk. | W. Bk. Tk. | W. Tk. | F. Bk. | Bk. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R. | 72 | — | — | 1 | 6 | 7 | — | — | 9 | 4 | — | — | 6 | 5 | 8 | — | 2 | — | — | — | 4 | — | — | — | — | — | — | 34 | 171 |
| R. F. | — | 22 | — | — | — | — | — | — | — | 1 | — | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 27 |
| R. or F. | — | — | — | — | — | — | — | — | 2 | — | — | — | 1 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | 4 |
| F. R. | 1 | — | — | 2 | — | 5 | — | — | 1 | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 5 |
| R. W. | 6 | — | — | — | 22 | 8 | — | — | — | — | — | — | 2 | — | — | — | 2 | — | — | — | 6 | — | — | — | — | — | — | — | 47 |
| W. R. | 7 | — | — | — | 5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 28 |
| F. R. W. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. R. or F. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| Bd. | 9 | — | — | — | — | — | — | — | 112 | 18 | 6 | — | 26 | 2 | 3 | — | — | — | — | — | 3 | — | — | — | — | — | — | 49 | 254 |
| Bd. W. | 4 | — | — | — | — | — | — | — | 18 | 28 | 5 | — | 2 | 4 | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 91 |
| W. Bd. | — | — | — | — | — | — | — | — | 6 | 5 | 22 | — | 1 | 2 | 4 | — | 1 | — | — | — | 1 | — | — | — | — | — | — | — | 58 |
| F. Bd. | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| F. | 6 | — | — | — | — | — | — | — | 26 | 2 | 1 | — | 54 | 7 | 5 | — | 2 | 2 | 1 | — | 7 | 5 | 13 | 4 | — | — | — | 35 | 163 |
| F. W. | 5 | — | — | — | — | — | — | — | 2 | 4 | — | — | 7 | 28 | 3 | — | 1 | 3 | — | — | 1 | 2 | 13 | 4 | — | — | — | 5 | 80 |
| W. F. | 8 | — | — | — | — | — | — | — | 3 | 1 | — | — | 5 | 3 | 20 | — | 3 | — | 1 | — | 1 | 1 | 2 | 7 | — | — | — | 5 | 64 |
| F. Bd. W. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | 2 | 2 | 4 | — | — | — | — | — | 3 |
| W. | 2 | — | — | — | — | — | — | — | — | 1 | — | — | — | 2 | 3 | — | 8 | — | 1 | — | 1 | 4 | 4 | — | — | — | — | — | 29 |
| Be. W. | — | — | — | — | — | — | — | — | 2 | 1 | — | — | — | 2 | 3 | — | 1 | — | 8 | 1 | 2 | — | 6 | — | — | — | — | 3 | 28 |
| W. Be. | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 | 3 | — | — | 1 | — | 1 | 2 | 1 | 4 | — | — | — | — | 3 | 16 |
| Be. Bd. W. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 1 |
| Be. | 4 | — | — | — | — | — | — | — | 3 | 1 | — | — | 7 | 1 | 1 | — | 4 | — | — | — | 30 | 5 | 3 | — | — | — | — | 31 | 92 |
| W. Be. | 10 | 1 | 1 | — | 6 | — | — | — | — | 2 | — | — | — | 5 | 13 | 2 | 4 | 6 | 2 | 4 | — | 140 | 30 | 30 | — | 1 | — | 28 | 282 |
| Bk. W. | 3 | — | — | — | — | — | — | — | — | — | — | — | — | 4 | 4 | 7 | — | — | — | — | — | 30 | 56 | — | 1 | — | — | 18 | 150 |
| W. Bk. | — | — | — | — | — | — | — | — | — | — | — | — | — | 7 | 2 | — | — | 4 | — | — | — | 3 | — | — | — | — | — | — | 1 |
| Bk. W. Tk. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 1 |
| W. Bk. Tk. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| W. Tk. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| F. Bk. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 7 |
| Bk. | 34 | 1 | — | — | 5 | 2 | — | — | 49 | 4 | 5 | — | 35 | 5 | 5 | — | 3 | 3 | — | — | 31 | 28 | 18 | — | 1 | — | — | 250 | 478 |
| Totals | 171 | 27 | 4 | 5 | 47 | 28 | 1 | 2 | 254 | 91 | 58 | 1 | 163 | 80 | 64 | 3 | 29 | 28 | 16 | 1 | 92 | 282 | 150 | 1 | 1 | 2 | 7 | 478 | 2086 |

# NOTE ON A RACE OF CLAUSILIA ITALA (VON MARTENS).

By W. F. R. WELDON.

In the first number of *Biometrika*, I described the result of measuring one of the elements on which the character of the shell-spiral depends in a race of *Clausilia laminata*. A comparison between the variability of the "peripheral radius" of the shell, in young and in adult individuals, afforded strong evidence that this character was subject to a process of "periodic selection" in the race studied.

In the early spring of 1902, I collected a number of individuals of *C. itala* (v. Martens) on the walls of the Citadel at Brescia, and I made a series of measurements of these, comparing 100 young and 100 adult individuals, as was done for *C. laminata*. The result of this comparison has been entirely negative; there is no evidence of su[illegible]ifference between young and adults, either in mean character or in variability, so to show that the elimination which occurs during growth is selective with regard to the characters measured. Although it is possible that an explanation of this result, not incompatible with the occurrence of a selective process, may yet be found, I think it right to publish the result at once, because this is, so far as I know, the first case in which young individuals have been shown to resemble the adults of their race, in the degree of development of characters which may perhaps be called specific, so exactly that it is difficult to believe in the occurrence of any selective elimination during growth.

The characters measured will be understood from the diagram, Fig. 1. Each shell was ground on a fine hone, until the columella was approximately cut in half along its whole length, the ground surface having the shape indicated in the diagram. The length of the columella in an adult shell is roughly from 13 to 16 mm., excluding the bent portion connected with the clausilium, while its breadth is never half a millimetre. The plane of a section which passes sensibly through the middle of this long and narrow tube cannot make an important angle with the plane which contains the axis of the shell. In young individuals, where the

columella is much shorter, the exactitude attainable by grinding is less; but it is still sufficient for our purposes.

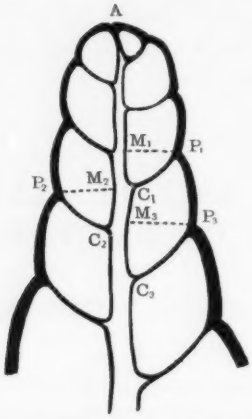


Fig. 1. The upper part of a section through *Clausilia itala*, showing the characters measured.

In any section, points on the peripheral and columellar spirals are exposed, and by passing alternately from one side of the sensibly flat section to the other, we find points on either spiral separated by an angular distance of 180°. It is evident that the relative positions of two points, $P_1$ and $P_2$ (Fig. 1) on the peripheral spiral, known to be 180° apart, are determined if we measure in the plane of the section the sides of the triangles $AP_1C_1$ and $AP_2C_2$. By proceeding in this way through the whole section, we might determine the law of growth of each side of the fundamental triangle $APC$, as it revolves round the columella, and so obtain data from which both peripheral and columellar spirals could be reconstructed. An attempt was made to do this; but the columellar end of the septum between two successive whorls, which determines the length of $PC$, was found to be so indefinite that the measurement of this side of the triangle was abandoned. The "peripheral radius," $AP$, called $P$ in the tables which follow, and the "columellar radius," $AC$, called $C$ in the tables, were measured; to obtain a measurement depending on the apical angle $PAC$, the perpendicular $PM$, from the peripheral spiral to the columella, was measured; it was found that by means of the perpendicular cross-lines in the eye-piece of a reading microscope it was easy to determine this perpendicular (called in the tables $p$) with sufficient accuracy.

The measurements were in all cases recorded to 0·01 mm., and care was taken to make them as accurate as possible; for purposes of tabulation, the more variable measures $P$ and $C$ were grouped so that the unit of tabulation was 0·05 mm., the less variable $p$ was tabulated in units each equal to 0·02 mm. The individuals measured were 100 adults and 105 young, the whole number of measures made being well over 9000, though only a part are here discussed.

Having made the measurements of all the sections, it was necessary to find some way of making the results, obtained from one section, comparable with those obtained from another. All that is known about the plane of a given section is, that it is one of the infinite number of planes passing approximately through the axis of the shell. There is no way of determining the angle between the plane of a section and that in which the spiral itself begins.

In comparing sections of *C. laminata*, the measures of the peripheral radius (the only character studied) were tabulated by reference to their angular distance from the plane containing a columellar radius 5 mm. long. Such a method, applied to young and old alike, gives results which are strictly comparable, and it therefore gives a reliable measure of the relative variability in young and in adults; it has however the great disadvantage that the absolute variability is so distorted that the standard deviation of peripheral radii, actually obtained, is nearly worthless as an indication of variability.

For the purposes of the present enquiry, an attempt was made, within the limits of every successive 180°, to determine *first* the mean length and standard deviation of each of the three elements measured, considered by itself, and *secondly* the mean and standard deviation of the array of any one element, associated with a fixed type of one or of both the others. Thus, starting with a columellar radius of 2 mm., in adult shells, and taking every length of this radius which occurred in the following half-revolution, it was found that the range of columellar radii in this particular half-revolution was from 2·00 to 2·49 mm. The mean and standard deviation of this group was determined. Taking the values of $P$ and of $p$, associated with these values of $C$, the mean and S.D. of each of these was also determined; then, by making the three correlation-tables between $C$ and $P$, $C$ and $p$, $P$ and $p$, the mean value and the standard deviation of any one of the three sets of measures, associated with fixed type of either or both the others, could also be found.

The mean values of the characters measured, as well as their standard deviations, are given for young and for adults in Table I: it will be seen that they are roughly identical. The degree of identity of mean character in corresponding regions of the young and adult shells cannot, however, be adequately judged from these results. Each entry in Table I, except those in the first column, records the Mean or the Standard Deviation of a character, as determined for a group of cases in which the columellar radius varied in length between the fixed limits given in the first column; but within these limits, the mean value of the columellar radius, and its standard deviation, are largely affected by the mean position and standard deviation of position of the planes in which the sections were cut. These quantities cannot be directly determined, and we have no right to assume without evidence that the mean position of the adult sections, with reference to the origin of the shell-spiral, was exactly the same as that of the sections of young individuals. In order to compare the two sets of results in a more useful way, the regression of peripheral radius-length and that of perpendicular on the length of the columellar radius has been determined from the correlation tables for all the measurements

## TABLE I.

*Mean Values and Standard Deviations of every Dimension measured for every Half-Revolution of the Shell-Spiral.*

(Measurements in millimetres.)

| Limits of Columellar Radius | Mean Columellar Radius | | S.D. of Columellar Radius | | Mean Peripheral Radius | | S.D. of Peripheral Radii | | Mean Perpendicular | | S.D. of Perpendiculars | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Young | Adult | Young | Adult | Young | Adult | Young | Adult | Young | Adult | Young | Adult |
| 2·00—2·49 | 2·2012 ±0·0101 | 2·2201 ±0·0094 | 0·1503 | 0·1388 | 1·9618 ±0·0095 | 1·9428 ±0·0091 | 0·1410 | 0·1348 | 0·5892 ±0·0028 | 0·5832 ±0·0031 | 0·0409 | 0·0457 |
| 2·50—3·09 | 2·7965 ±0·0106 | 2·7807 ±0·0118 | 0·1577 | 0·1754 | 2·4518 ±0·0096 | 2·4470 ±0·0113 | 0·1429 | 0·1679 | 0·6947 ±0·0031 | 0·6886 ±0·0036 | 0·0462 | 0·0537 |
| 3·10—3·79 | 3·4692 ±0·0129 | 3·4528 ±0·0132 | 0·1913 | 0·1954 | 3·0176 ±0·0132 | 3·0427 ±0·0125 | 0·1953 | 0·1859 | 0·8165 ±0·0038 | 0·8191 ±0·0042 | 0·0563 | 0·0622 |
| 3·80—4·54 | 4·1498 ±0·0152 | 4·1334 ±0·0135 | 0·2258 | 0·2002 | 3·6685 ±0·0152 | 3·6747 ±0·0128 | 0·2249 | 0·1896 | 0·9605 ±0·0051 | 0·9707 ±0·0046 | 0·0753 | 0·0688 |
| 4·55—5·49 | 4·9990 ±0·0181 | 5·0040 ±0·0194 | 0·2690 | 0·2882 | 4·4666 ±0·0175 | 4·4703 ±0·0195 | 0·2592 | 0·2887 | 1·1348 ±0·0056 | 1·1512 ±0·0059 | 0·0831 | 0·0871 |
| 5·50—6·54 | 5·9970 ±0·0202 | 6·0519 ±0·0206 | 0·2998 | 0·3050 | 5·3740 ±0·0206 | 5·4216 ±0·0200 | 0·3050 | 0·2963 | 1·3447 ±0·0066 | 1·3272 ±0·0067 | 0·0982 | 0·0986 |
| 6·55—7·64 | 6·9687 ±0·0219 | 7·0755 ±0·0194 | 0·3245 | 0·2879 | 6·3902 ±0·0224 | 6·4632 ±0·0186 | 0·3318 | 0·2758 | 1·5221 ±0·0075 | 1·5326 ±0·0060 | 0·1115 | 0·0889 |

of young shells, and the mean value of each of these dimensions, associated with a columellar length identical with the mean found for adults in every half-revolution, has been determined. The two sets of values are given in Table II, from which it will be seen that the values in both series are very close together, and although the differences between the corresponding values of the perpendiculars are considerable in the lower whorls, they are so irregular that it is

TABLE II.

*Mean Peripheral Radius and Mean Perpendicular corresponding to identical Values of the Columellar Radius.*

| Columellar Radius | Mean Peripheral Radius | | Mean Perpendicular | |
|---|---|---|---|---|
| | Adult | Young | Adult | Young |
| 2·2201 | 1·9428 | 1·9783 | 0·5832 | 0·5919 |
| 2·7807 | 2·4470 | 2·4383 | 0·6886 | 0·6927 |
| 3·4528 | 3·0427 | 3·0020 | 0·8191 | 0·8134 |
| 4·1334 | 3·6747 | 3·6527 | 0·9707 | 0·9569 |
| 5·0040 | 4·4703 | 4·4711 | 1·1512 | 1·1358 |
| 6·0519 | 5·4216 | 5·4268 | 1·3272 | 1·3555 |
| 7·0755 | 6·4632 | 6·4951 | 1·5326 | 1·5432 |

difficult to regard them as significant. We may therefore say that in young shells, from 7 to 8 mm. in length, the mean length of the peripheral radius, or that of the perpendicular from the peripheral spiral on the columella, corresponding to a given length of columellar radius, is sensibly identical with the mean value of the corresponding character of an adult shell,—or more shortly, the mean spiral is sensibly identical in young and in adults. There is clearly no room here for the suggestion that selection, or any other process, is changing the mean character of the spiral at a rate which produces any sensible effect between one generation and the next. Such an identity between the mean character of young and of adults was demonstrated for the peripheral radii of *C. laminata*, and the speedy establishment of such an identity is to be expected in every local race, if the Law of Ancestral Inheritance be well founded. The only selective process, which remains to be looked for, is what Pearson has called "periodic selection," by which the variability of the race is reduced in every generation during growth, the mean character remaining unchanged in this, though not in all such cases.

The standard deviations of the groups of measurements included in every half-revolution studied are given in Table I.; but these are obviously affected by the planes of the sections, and cannot be used in comparing variability. The measure of relative variability, which seems most reliable, is that given by a comparison between the standard deviations of arrays of one dimension in young and adult respectively, corresponding to the same fixed type of either or both of the others.

In order to determine this, the first step was to find the correlations between the dimensions measured, taken in pairs: the correlation coefficients obtained are given in Table III. They were determined for each group corresponding to half a

TABLE III.

*Correlations between the Dimensions measured for every Half-Revolution of the Shell-Spiral.*

| Limits of $C$ | $r_{CP}$ | | $r_{Cp}$ | | $r_{pP}$ | |
|---|---|---|---|---|---|---|
| | Young | Adult | Young | Adult | Young | Adult |
| 2·00—2·49 | 0·9281 ±0·0094 | 0·9412 ±0·0077 | 0·5296 ±0·0485 | 0·6727 ±0·0369 | 0·5950 ±0·0436 | 0·6624 ±0·0379 |
| 2·50—3·09 | 0·9451 ±0·0072 | 0·9528 ±0·0062 | 0·5932 ±0·0437 | 0·7048 ±0·0339 | 0·6317 ±0·0405 | 0·7285 ±0·0317 |
| 3·10—3·79 | 0·9351 ±0·0085 | 0·9439 ±0·0074 | 0·6340 ±0·0403 | 0·6589 ±0·0382 | 0·6552 ±0·0385 | 0·6090 ±0·0424 |
| 3·80—4·54 | 0·9647 ±0·0047 | 0·9449 ±0·0072 | 0·6575 ±0·0383 | 0·5510 ±0·0470 | 0·6770 ±0·0365 | 0·5874 ±0·0442 |
| 4·55—5·49 | 0·9412 ±0·0077 | 0·9691 ±0·0041 | 0·6591 ±0·0381 | 0·6551 ±0·0385 | 0·6623 ±0·0379 | 0·6678 ±0·0374 |
| 5·50—6·54 | 0·9450 ±0·0074 | 0·9491 ±0·0067 | 0·5980 ±0·0433 | 0·6205 ±0·0415 | 0·6448 ±0·0394 | 0·6412 ±0·0397 |
| 6·55—7·64 | 0·9609 ±0·0052 | 0·9048 ±0·0122 | 0·5737 ±0·0452 | 0·4509 ±0·0537 | 0·6281 ±0·0408 | 0·5362 ±0·0481 |

revolution of the shell-spiral, because within these limits the lines of regression were seen to be sensibly straight, and the ordinary measure of the standard deviation of an array could therefore be used with confidence. The high values obtained for correlation between the columellar radius and the peripheral radius seem to show that the measurements were fairly trustworthy, but at the same time the differences between values obtained for corresponding sets of measures in young and in adults are so great and so irregular that it is difficult to see how they can be due to any other cause than error of measurement. In series of only about 100 measures, a single small error of measurement could easily change the second decimal of a correlation coefficient so high as 0·95.

From the correlation coefficients, and the standard deviations of the various groups, the standard deviations of arrays were calculated in the usual way, the results being given in Table IV. In this table $P$ means peripheral radius, $C$ columellar radius, and $p$ the perpendicular from the peripheral spiral on the columella. The standard deviation of an array of peripheral radii, associated with a fixed length of columellar radius, is given by the value of $\sigma_P\sqrt{1-r^2_{CP}}$; and similarly in other cases. It will be seen from Table IV. that there is no case in which the standard deviations of the arrays of measures from young shells are

consistently greater than those of the corresponding arrays from adult shells. In all cases the values obtained cross and re-cross each other in such a way that we cannot infer greater variability in either series than in the other, and we have therefore no proof that any selective elimination of young occurs.

TABLE IV.

*Standard Deviations of Arrays of Peripheral Radii, and of Perpendiculars on the Columella, corresponding to fixed type of one other Dimension. The Determinations made within the limits of Columellar Radius-length indicating half a Revolution of the Shell-spiral.*

| Limits of Columellar Radius-length | $\sigma_P\sqrt{1-r^2_{CP}}$ | | $\sigma_P\sqrt{1-r^2_{pP}}$ | | $\sigma_p\sqrt{1-r^2_{Cp}}$ | | $\sigma_p\sqrt{1-r^2_{Pp}}$ | |
|---|---|---|---|---|---|---|---|---|
| | Young | Adult | Young | Adult | Young | Adult | Young | Adult |
| 2·00—2·49 | 0·0525 | 0·0456 | 0·1125 | 0·1039 | 0·0347 | 0·0338 | 0·0328 | 0·0342 |
| 2·50—3·09 | 0·0467 | 0·0509 | 0·1110 | 0·1165 | 0·0372 | 0·0381 | 0·0358 | 0·0367 |
| 3·10—3·79 | 0·0692 | 0·0614 | 0·1453 | 0·1474 | 0·0436 | 0·0468 | 0·0426 | 0·0493 |
| 3·80—4·54 | 0·0592 | 0·0621 | 0·1675 | 0·1535 | 0·0567 | 0·0574 | 0·0554 | 0·0557 |
| 4·55—5·49 | 0·0876 | 0·0712 | 0·1953 | 0·2151 | 0·0624 | 0·0658 | 0·0622 | 0·0648 |
| 5·50—6·54 | 0·0997 | 0·0933 | 0·2312 | 0·2257 | 0·0787 | 0·0773 | 0·0751 | 0·0757 |
| 6·55—7·64 | 0·0918 | 0·1174 | 0·2589 | 0·2334 | 0·0748 | 0·0916 | 0·0728 | 0·0750 |

To test the possibility of selective elimination still further, the standard deviation of an array was determined in every group of measures, for fixed type of *two* dimensions; the S.D. of peripheral radius-lengths, for fixed type of columellar lengths and perpendiculars, being equal to

$$\sigma_P\sqrt{1-\frac{r^2_{CP}+r^2_{Pp}-2r_{CP}r_{Cp}r_{Pp}}{1-r^2_{Cp}}},$$

a similar expression giving the standard deviation of perpendiculars, for fixed types of columellar and peripheral radii. The results, given in Table V., show no indication that the variability of adult arrays is less than that of the corresponding arrays of young individuals, so that here again the attempt to demonstrate a selective elimination during growth is unsuccessful.

The method employed in determining the variability of the arrays depends of course for its validity on the linear character of the regression in each case. It does not seem worth while to publish the whole series of 21 correlation tables, from which the results were obtained, but the diagram Fig. 2, chosen at random from the series, gives a fair idea of the regression, and in this diagram, at least, there is no doubt of its linear character.

TABLE V.

*Standard Deviations of Arrays of* P *and* p, *each corresponding to fixed type of both the other Dimensions measured.*

| Limits of *C* | S. D. of *P* for fixed *C* and *p* | | S. D. of *p* for fixed *P* and *C* | |
|---|---|---|---|---|
| | Young | Adult | Young | Adult |
| 2·00—2·49 | 0·0496 | 0·0452 | 0·0327 | 0·0334 |
| 2·50—3·09 | 0·0449 | 0·0519 | 0·0359 | 0·0367 |
| 3·10—3·79 | 0·0669 | 0·0611 | 0·0424 | 0·0467 |
| 3·80—4·54 | 0·0484 | 0·0546 | 0·0550 | 0·0556 |
| 4·55—5·49 | 0·0863 | 0·0701 | 0·0621 | 0·0647 |
| 5·50—6·54 | 0·0949 | 0·0912 | 0·0750 | 0·0756 |
| 6·55—7·64 | 0·0863 | 0·1106 | 0·0858 | 0·0747 |

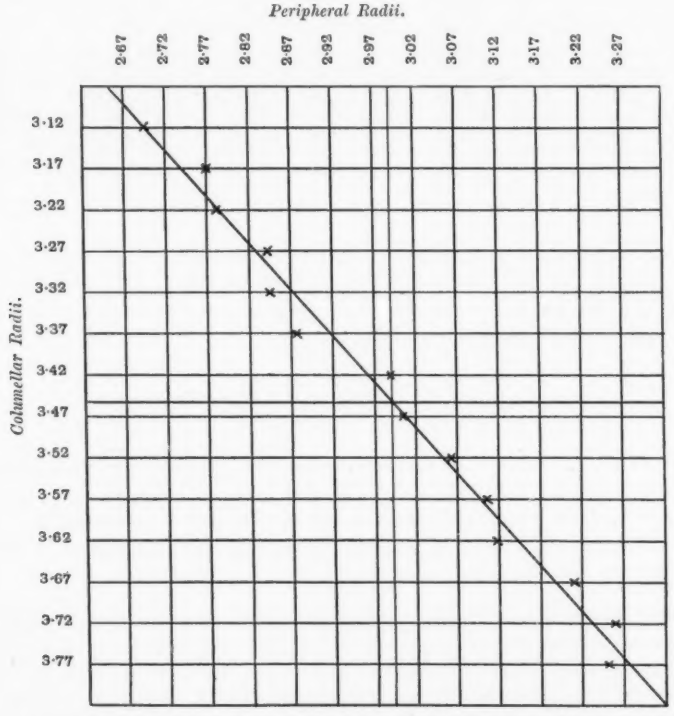


Fig. 2. Regression of Peripheral Radii on Columellar Radii for adult individuals of Columellar radius length from 3·10—3·79 mm.

The negative result so far obtained may conceivably be due to either of three causes:

(1) The characters of the shell-spiral investigated may not be now subject to selective elimination in *C. itala* at all; the correlations already established between the various dimensions measured may result in such mutual adjustment of the parts that within the narrow limits of observed variability any combination of magnitudes of these dimensions, which actually occurs, is sensibly as efficient as any other.

(2) The construction of a garden and of public walks round the Citadel of Brescia is a recent thing, and has possibly led to a recent introduction of *Clausilia*: the condition of the walls of the Citadel is certainly not at present that of an important military fortification; the growth of herbage, the falling out of mortar, and other conditions favourable to the multiplication of *Clausilia*, have certainly been emphasised during the past few years. It is therefore possible that we have here a new colony, multiplying under exceptionally favourable conditions, and so exempt from forms of selection which affect the species in other localities.

(3) The individuals measured, both young and old, were gathered in early spring, after their winter sleep. It is possible that selective elimination of the young takes place largely during the winter, and that individuals of the same length, collected in the autumn, at the close of their period of growth, might be more variable than those which survive the winter.

The data at present available do not permit us to decide which of these suggested possibilities represents the truth. I hope to collect evidence on the point during the autumn of this year; I have ventured to publish this preliminary note because the failure to demonstrate selective elimination in any such case as this appears to me in itself a result of some importance.

# MISCELLANEA.

## On an Elementary Proof of Sheppard's Formulae for correcting Raw Moments and on other allied Points.

[EDITORIAL.]

SEVERAL biometricians having expressed difficulties to the editors concerning the proof and use of Sheppard's corrections in calculating moments, we venture to publish the following elementary consideration of the subject taken from manuscript notes of the past few years. For the complete treatment of the subject the reader must always refer to the original paper*.

Let the equation to the frequency distribution be

$$y=\phi(x),$$

$y\delta x$ being the frequency between $x$ and $x+\delta x$. Let $h$ be the base unit for grouping the raw material. Let $N$ be the total frequency and $n_r$ the frequency on the $r$th base unit $h$, between $x_r-\frac{1}{2}h$ and $x_r+\frac{1}{2}h$. Let $y_r'$ be any ordinate corresponding to $x_r+x'$. Then

$$n_r=\int_{-\frac{1}{2}h}^{+\frac{1}{2}h} y_r'dx'=\int_{-\frac{1}{2}h}^{\frac{1}{2}h}\phi(x_r+x')\,dx'.$$

Now if $\phi(x)$ be a continuous function which can be expanded by Taylor's Theorem, i.e. $\phi^s(x)$ does not become infinite within the range used:

$$\begin{aligned} n_r&=\int_{-\frac{1}{2}h}^{+\frac{1}{2}h}\left\{\phi(x_r)+x'\phi'(x_r)+\frac{x'^2}{1\,.\,2}\phi''(x_r)+\ldots\right\}dx' \\ &=h\phi(x_r)+\frac{h^3}{24}\phi''(x_r)+\frac{h^5}{1920}\phi^{\mathrm{iv}}(x_r)+\text{etc.} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\text{(i).}\end{aligned}$$

Now $x_r$ is clearly here any abscissa of the frequency curve and this expression gives the frequency on a strip taken anywhere, provided it has a base $h$ and mid-abscissa $x_r$. It follows that if $\Sigma$ denote a sum for all values of $r$,

$$\Sigma(n_r(x_r)^s)=h\Sigma(\phi(x_r)(x_r)^s)+\frac{h^3}{24}\Sigma(\phi''(x_r)(x_r)^s)+\frac{h^5}{1920}\Sigma(\phi^{\mathrm{iv}}(x_r)(x_r)^s)+\text{etc.} \ldots\ldots\text{(ii)},$$

where $s$ is any positive integer.

* W. F. Sheppard: "On the Calculation of the most Probable Values of Frequency Constants, for Data arranged according to Equidistant Divisions of a Scale." *Proc. Lond. Math. Soc.* Vol. XXIX, p. 353 et seq.

Now it is a well-known theorem due to Euler and Maclaurin* that if $f(x)$ be any function of $x$,

$$\int f(x)\,dx = \Sigma h f(x_r) - \left[\frac{h}{2} f(x) + \frac{h^2}{12} f'(x) - \frac{h^3}{720} f'''(x) + \ldots\right] \ldots\ldots\ldots\ldots\ldots\text{(iii)},$$

where the term in brackets is to be given its values at the limits of the integration on the left. Hence if $f(x)$, $f'(x)$, $f'''(x)$ etc., all vanish at the ends of the range of values under consideration, we have simply

$$\Sigma h f(x_r) = \int f(x)\,dx \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(iv)}.$$

Now suppose $\phi^p(x)x^s$ are functions which for different values of $p$ and $s$ are such that they and their differential coefficients vanish at the ends of the range of frequency. Then

$$\Sigma\{n_r(x_r)^s\} = \int \phi(x)\,x^s dx + \frac{h^2}{24}\int \phi''(x)\,x^s dx + \frac{h^4}{1920}\int \phi^{iv}(x)\,x^s dx + \ldots \ldots\ldots\ldots\text{(v)}.$$

But by integrating by parts

$$\int \phi^p(x)\,x^s dx = [\phi^{p-1}(x)\,x^s - s\phi^{p-2}(x)\,x^{s-1} + s(s-1)\,\phi^{p-2}(x)\,x^{s-2} + \ldots] \ldots\ldots\text{(vi)}.$$

This clearly vanishes at both limits if $p$ be greater than $s$. Hence no term of (v) need be retained for which $p$ is greater than $s$.

Put $s$ successively 0, 1, 2, 3, 4, we find

$$\begin{aligned}
\Sigma(n_r) &= \int \phi(x)\,dx = N,\\
\Sigma(n_r x_r) &= \int \phi(x)\,x dx = N\mu_1',\\
\Sigma(n_r x_r^2) &= \int \phi(x)\,x^2 dx + 2\,\frac{Nh^2}{24} = N\left(\mu_2' + \frac{1}{12}h^2\right),\\
\Sigma(n_r x_r^3) &= \int \phi(x)\,x^3 dx + 6\,\frac{h^2}{24}\int \phi(x)\,x dx = N\left(\mu_3' + \frac{h^2\mu_1'}{4}\right),\\
\Sigma(n_r x_r^4) &= \int \phi(x)\,x^4 dx + \frac{h^2}{2}\int \phi(x)\,x^2 dx + \frac{24h^4}{1920}N = N\left(\mu_4' + \frac{1}{2}h^2\mu_2' + \frac{1}{80}h^4\right) \ldots\ldots\text{(vii)}.
\end{aligned}$$

Here $\mu_1'$, $\mu_2'$, $\mu_3'$, $\mu_4'$ multiplied by $N$ are the true first four moments about the axis of $y$ of the frequency curve. If we take the axis of $y$ through the mean, we find $\mu_1' = 0$, and if we write for the moments about the mean $N\mu_2$, $N\mu_3$, $N\mu_4$ and $N\nu_1$, $N\nu_2$, $N\nu_3$, $N\nu_4$ for the moments of the frequencies $n_r$ about the mean, we find, since $\Sigma(n_r x_r^s) = N\nu_s$,

$$\left.\begin{aligned}
&\mu_0 = \nu_0 = 1, \quad \mu_1 = \nu_1 = 0\\
&\mu_2 = \nu_2 - \frac{h^2}{12}, \quad \mu_3 = \nu_3\\
&\mu_4 = \nu_4 - \frac{h^2}{2}\nu_2 + \frac{7h^4}{240}
\end{aligned}\right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(viii)}.$$

In other words the area, the centroid and the third moment are not changed by using group frequencies for ordinates, and from the second and fourth moments we have to subtract

$$\frac{1}{12}h^2 \quad \text{and} \quad \frac{1}{2}h^2\nu_2 - \frac{7}{240}h^4$$

respectively, supposing the raw moments already referred to the mean. These are the well-known Sheppard's corrections.

* Boole's *Finite Differences*, Chapter V. The expansion of course depends on $f(x)$ satisfying continuity conditions.

It will be noted at once that the assumptions made are (i) that Taylor's Theorem may be applied to the frequency function throughout the range, i.e. $\phi(x)$ and its derivatives must be finite and continuous throughout the range; further (ii) that $x^s\phi^{(p)}(x)$, where $s$ and $p$ are any integers, and its derivatives are finite and continuous throughout the range, and (iii) that $\phi(x)$ and its differentials vanish at the limits.

Now (ii) practically flows from (i), but (iii) is a weak spot and must be borne carefully in mind when the corrections are applied. It amounts to saying that the contact is of an indefinitely high order at the ends of the range. This is by no means generally true, the curve frequently meeting the character axis at a finite angle, or even being perpendicular to it. In such cases special processes must be adopted to correct the moments*. The real trouble of the analysis often lies in the fact that until the curve has been fully calculated out, we are not in a position to determine the nature of the contact at the terminals, i.e. we want to know the moments before we can determine whether they ought to be corrected by Sheppard or not. In some cases the graphical representation may suffice to indicate the nature of the contact, but it is by no means conclusive, often indeed misleading.

This arises to some extent from the fact that we usually deal with areas, not ordinates, in plotting such graphical representations. If we accept an expansion up to $h^4$ as giving approximately enough for practice the value of $n_r$ in terms of $y_r$, we can deduce a number of quite useful results from equations like (i). For example, let us take the normal curve:

$$y=\frac{N}{\sqrt{2\pi}\sigma}e^{-\frac{1}{2}\frac{x^2}{\sigma^2}}.$$

Here
$$\phi''(x)=y\frac{x^2-\sigma^2}{\sigma^4},$$

$$\phi^{\text{iv}}(x)=y\frac{x^4-6\sigma^2x^2+3\sigma^4}{\sigma^8}.$$

Hence
$$n_r=hy_r\left\{1+\frac{h^2}{24}\frac{x_r^2\sigma^2}{\sigma^4}+\frac{h^4}{1920}\frac{x_r^4-6\sigma^2x_r^2+3\sigma^4}{\sigma^8}\right\}.$$

Now the second and third terms will be largest when $x_r$ is biggest, say $x_r=3\sigma$ in practice. In this case

$$n_r=hy_r\left\{1+\frac{1}{3}\left(\frac{h}{\sigma}\right)^2+\frac{1}{64}\left(\frac{h}{\sigma}\right)^4\right\}.$$

But $h$ will hardly be as large as $\frac{1}{2}\sigma$, or say about 12 groups. Then we have

$$n_r=hy_r\left\{1+\frac{1}{12}+\frac{1}{1024}\right\}.$$

Thus the term in $h^4$ even at maximum is for practical purposes negligible, but the term in $h^2$ may amount to as much as 8 per cent. Accordingly we conclude that the frequency may be found from the ordinate in the case of the normal curve by the formula

$$n_r=hy_r\left\{1+\frac{h^2}{24}\frac{x_r^2-\sigma^2}{\sigma^4}\right\}.$$

There is another way of looking at this result. Consider the expression

$$u_r=\frac{N}{\sqrt{2\pi}\sigma_0}e^{-\frac{1}{2}\frac{x_r^2}{\sigma_0^2}},$$

and put $\sigma_0^2=\sigma^2+ph^2$, we have on expanding and retaining powers of $h$ up to $h^4$,

$$u_r=\frac{N}{\sqrt{2\pi}\sigma}e^{-\frac{1}{2}\frac{x^2}{\sigma^2}}\left\{1+\frac{ph^2(x_r^2-\sigma^2)}{2\sigma^4}+\frac{p^2h^4}{8}\frac{x_r^4-6\sigma^2x_r^2+3\sigma^4}{\sigma^8}\right\}.$$

* See, for example, *Biometrika*, Vol. I. pp. 282—88.

Or, if $p$ be taken $=\frac{1}{12}$

$$u_r=\phi(x_r)+\frac{h^2}{24}\phi''(x_r)+\frac{h^4}{1152}\phi^{iv}(x_r).$$

Thus
$$n_r-hu_r=-\frac{h^4\phi^{iv}(x_r)}{2880},$$

which is in all practical cases of no importance.

Hence $n_r=h\times u_r$, or the frequencies are given by the ordinates of a normal curve for which the standard deviation is $\sigma^2+\frac{1}{12}h^2$, but if $N\nu_2$ be the 'raw' second moment about the mean we have seen above that $\sigma^2=\nu_2-\frac{1}{12}h^2$. Thus $\sigma_0^2=\nu_2$, very closely. Or, we conclude that:

*If the ordinates of a normal curve be calculated from the raw second moment value of the standard deviation, these ordinates will more closely represent the actual frequencies than do the ordinates of the true normal curve, which have to be corrected by the factor*

$$1+\frac{1}{24}h^2\frac{x_r^2-\sigma^2}{\sigma^2}$$

*to obtain the actual frequencies.*

If therefore our sole object is to compare observed and calculated frequencies for a definite series of groups, there are advantages in using the raw second moment in the equation to the curve. Such a curve has been termed by Sheppard a 'spurious curve of frequency.' Generally if the raw moments be used to calculate such a spurious curve its ordinates will give the frequencies, but the constants of such a curve are not the constants of the true frequency distribution, but functions of $h$ the unit of grouping.

As we want as a rule both the constants of the true frequency distribution (for comparative purposes), and the theoretical frequencies to compare with the observed frequencies, we are in some difficulty in the case of curves, which unlike the normal curve, have not their areas tabled. We have either to calculate the spurious curve as well as the true curve, or devise some process by which the areas of the true curve may be found from its ordinates for small ranges $h$.

We have used for some time past the following formulae for finding areas in terms of mid-ordinates in the case of skew curves of frequency:

(i) Normal Curve: Origin at mode.

$$y=y_0e^{-\frac{x^2}{2\sigma^2}}.$$

Area of strip on base $h$

$$=h\times y\left[1+\frac{1}{24}\frac{h^2}{\sigma^2}\frac{x^2-\sigma^2}{\sigma^2}\right].$$

(ii) Curve of type: Origin at mode and $p=a\gamma$.

$$y=y_0\left(1+\frac{x}{a}\right)^p e^{-\gamma x}.$$

Area of strip on base $h$

$$=h\times y\left[1+\frac{1}{24}\frac{h^2}{\sigma^2}\frac{(p+1)x^2-p\sigma^2)}{(x+a)^2}\right]$$

($p$ must be $>2$, if this is to be of value near the terminal of the curve).

(iii) Curve of type: Origin at mode.

$$y=y_0\left(1+\frac{x}{a_1}\right)^{m_1}\left(1-\frac{x}{a_2}\right)^{m_2}.$$

Area of strip on base $h$

$$=h\times y\left[1+\frac{h^2}{24}\frac{(m_1+m_2)\{x^2(m_1+m_2-1)-a_1a_2\}}{d_1^2d_2^2}\right],$$

where $d_1$ and $d_2$ are the distances of the foot of the ordinate $y$ from the terminals of the range.

(iv) Curve of type: Mode at distance $x_0=-\frac{\nu}{2m}$ from origin.

$$y=y_0\frac{1}{\left(1+\frac{x^2}{a^2}\right)^m}e^{-\nu\tan^{-1}\frac{x}{a}}.$$

Area of strip on base $h$

$$=h\times y\left[1+\frac{h^2}{24}\frac{2m}{(a^2+x^2)^2}\{2m+1\,(x-x_0)^2-(a^2+x_0^2)\}\right].$$